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DEPARTMENTAL NOTES

ON

INSECTS THAT AFFECT FORESTRY,

BY

E. P. STEBBING, F.L.S., F.E.S.,

FOREST ENTOMOLOGIST UNDER THE GOVERNMENT OF INDIA.

No. 2.

CALCUTTA:
OFFICE OF THE SUPERINTENDENT OF GOVERNMENT PRINTING, INDIA.
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PREFACE.

THE object of issuing the Departmental Notes on Insects that affect forestry in India in their present form is to enable the Officers of the Department and others interested in the culture of trees to keep up to date with our knowledge of the subject and to assist the advancement of the work by studying the still unknown portions of the life histories of the various pests detailed and of others still unrecorded. To this end, criticism and discussion are cordially invited.

Several of the insects dealt with are new to science, and most of the information on their habits, etc., is new. It has not been considered necessary here, however, to give in full detail the reasons for the statements made with reference to some of the new and more complex of the life histories. The author hopes to publish elsewhere full and detailed technical papers dealing with the matter from the scientific standpoint.

It is proposed to give information in these notes upon—

i.—Hurtful Insects.
ii.—Useful Insects.

Owing to queries having been received on the subject it should perhaps be pointed out that the descriptions of the insects do not aim at being scientific ones, they having been drawn up merely as simple aids to identifying the insects by fellow-workers in the field. It is hoped that the new species will be described with the help of scientific confrères. The writer hopes in time to deal himself with the *Scolytidæ* and *Platypodæ* of which already considerable collections of unknown species have been made.

E. P. STEBBING.

DEHRA DUN;
The 25th October 1902.

No. 2.

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SIREX SP.

Plate VII, fig 1, a–f.

Reference :—Provisionally determined as *Sirex* sp.

Classification :—Order, HYMENOPTERA. Family Siricidæ or Uroceridæ.

Tree attacked :—*Picea Morinda* (Spruce).

Description.

Larva.—A stout canary-yellow thick grub, about 1¼ inches in length and just under ⅓rd inch breadth. Head small and yellow with brownish black mandibles, toothed on their upper edges giving them the appearance of molar teeth. The thoracic segments are enlarged, the anterior one almost forming a hood over the small head. These segments each bear on their under surfaces a pair of small projections representing the thoracic legs. There are no other legs behind these, but some slight protuberances take their place. Following these three segments are nine others, the terminal one of which is enlarged and ends in a brownish black spike bearing a few short spines upon it. On either side of each segment there is an elliptical brownish spiracle placed anteriorly. (See Pl. VII, fig. 1, a.)

Pupa. ♀.—A pale yellow in colour, unenclosed in any covering and lies quite free at the end of the larval boring. All the parts of the future insect are developed but, with the exception of the eyes, which are brown and elliptical, they are all of a uniform pallid colour in the initial stages. In the pupa being described the palpi, antennæ, legs and wings (about one-third their future length) were all quite free and pressed close to the ventral side of the insect. The three parts of the ovipositor were present and separated, as also the augur terminating the last segment. Length to end of augur 1⅛ inches. Ovipositor ⅜ths of an inch. The pupa described is a female. The male has of course no ovipositor. (See Pl. VII, fig. 1, b.)

Imago. ♂.—A large handsome insect. General colouring a metallic blue-green and rich chestnut. Head and thorax very dark metallic green-black and clothed with hair, which is dense on the dorsal surface of the thorax; antennæ bristle-like, 22-jointed, a little over ⅓rd length of insect, the first five joints being chestnut brown, the other 17 joints black; the first joint is thickened and longer than the others. Legs long, chestnut brown in colour except the posterior tibiæ and 1st tarsal joint, which are black and very much flattened out. Anterior tibia is armed at its base with a spur. These tibiæ and tarsal joints are doubtless used to push out wood-dust from the galleries as the insect moves forward in its boring operations. The tarsi terminate in a pair of curved sharp claws, which are spined at their junction. Wings membranous with a rich coppery sheen; they reach to the end of the insect, leaving only the portion of the body bearing the short augur uncovered. In the upper wing there are two marginal cells, the lower one of which does not reach the end of the wing, and three submarginal cells. The middle portion of the wing is occupied by six cells, none of which reach the outer edge, the two centre ones of which are the smallest. There are three veins on the lower marginal edge, the one nearest the outer edge being the smallest. Under surface of thorax black-green. Body is flattened, shining and smooth; first three segments of abdomen metallic green, shading off laterally on the third into red, the following four dark metallic red with a dash of yellow in it, the lower edge of the fourth being ultramarine blue, the seventh a pale ultramarine brown and the last ultramarine. These last two segments glow brilliantly when they catch the light. Each of the red segments has on the posterior edge of its dorsal surface a spot of ultramarine. Under surface of abdomen same as upper, except that both the last segments are a brilliant metallic ultramarine.

Length just under 1⅜th inches. (Described from a living specimen. See Pl. VII, fig. 1, c.)

♀. Head and thorax a deep metallic green above, beneath clothed with hair as in ♂. Legs chestnut brown, except coxæ and trochanters which are dark metallic blue, and last tarsal joint and claws, which are black; posterior tibia and 1st tarsal joint not thickened. Wings with a rich old gold metallic lustre with thick well-marked black veins. The wings leave the last segment of the body and the augur exposed. The abdomen is smooth and is a brilliant metallic blue verging to black on the under surface. Ovipositor consisting of three portions and black in colour, $\frac{11}{16}$th inch in length. Length $1\frac{7}{16}$th inch to end of ovipositor, and $1\frac{1}{4}$th inch to end of augur. (See Pl VII, fig. 1, d.)

Life History.

This insect appears on the wing about the middle of June, perhaps earlier. It attacks spruce trees, and the writer has found it at the end of the month both in the wood and flying about in the forest. The insect is to be found in all its stages of larva, pupa, and imago at this period.

The eggs are laid by the female in the wood of dead spruce trees (I think it possible that blue pine and perhaps other trees are also attacked by it or an allied species) some time during July. The larvæ on hatching out are small yellowish grubs and bore straight into the wood, in which they remain feeding and tunnelling for over a year. The latter is, I think, probable, since I have found small larvæ and large full-grown ones together in the same tree. The length of time spent in the pupal stage is not at present known. Pupæ have been found in the tunnels in the middle of June and on into July, and it is probable that the adults issue at intervals for several weeks until the burst of the monsoon. On becoming mature the *Sirex* bores its way out of the wood to the outside, the tunnel being either horizontal or at an angle, depending apparently on the position of the larva when it ceased feeding. When this latter occurs the head of the larva is generally, if not always, pointing in the direction of the outside of the tree, and not facing inwards, but as often as not this tunnel is at an upward angle. The imago will then bore in a line straight for the outside, but the tunnel may be curved upwards. I have never found imago-tunnels pointing downwards. The larval gallery is always tightly packed with dry wood chips, so that during its feeding operations it is always moving forward, and when full fed the only free part of its gallery is the space it is lying in. The depth within the tree at which it changes into the pupal condition appears to vary.

It may be only an inch inside the sapwood or several inches. The imago cuts its way out by means of its powerful mandibles, making a circular hole through the wood and bark of a ¼ inch in diameter.[1]

Locality from where reported.

This insect was discovered by the writer in dead spruce trees in Tehri Garhwal, North-West Himalayas (Jaunsar Division), at an elevation of about 7,000 feet.

Relations to the Forest.

The injury done by this insect is entirely to the commercial value of the wood, the timber, when the larvæ are numerous, being riddled by their borings. (See Plate VII, fig. 1, e.) I have not ascertained how deep the borings go in large trees, but in a spruce of 3 feet diameter I found tunnels as deep as 1 foot in from the outer edge of the sapwood, excluding the bark. The young larva soon after getting into the wood turns at an angle and bores up and down in the longitudinal axis of the tree, and a section of the wood of a badly attacked tree will show numerous galleries packed tightly with the wood chips. (See figure 1, e.) The tunnel is small in diameter at first but increases until, when the occupant is full grown, it is ¾ inch in circumference. It is invariably very tortuous.

Whilst the damage done to the timber by the larvæ is of itself very considerable, it is increased by the exit holes bored by the adults, and these let in moisture and fungi which soon ruin the rest of the sound timber. In Pl. VII, fig. 1, f, the larger holes and galleries in the bark are those of this insect.

Protection and Remedies.

We require to know exactly what species of trees are attacked by this insect before we can decide as to the damage to be expected from it. As long as timber is cut up and sold green it would appear that the pest is not to be feared, since it probably does not commence its attacks until the tree is either dead or felled. Ringing trees is to be avoided where such insects exist in a forest, as it provides them with exactly the food they require. Dead trees should, whenever possible, be cut out and removed.

---

[1] Since this note went to press I have bred out adults of this species at Dehra Dun from wood brought down from Jaunsar in July and kept under supervision. A male issued on the 22nd September and a female on the 1st October. The male specimen is smaller than those obtained in the Himalayas in June and July. The female is the first specimen of that sex obtained. I am of opinion that the lower elevation of Dehra (2,000 ft. only), and the consequently hotter climate, is the cause of these insects appearing at this time of the year. It is improbable, I think, that the mature insects ordinarily appear more than once in the year, *i.e.*, in June and July.

Points in the life history requiring further observation.

1. How the eggs are laid. Does the ♀ cut through the bark into the wood with her ovipositor and a ugur and lay them in the wood? Is the bark necessary to the ♀ or will she lay her eggs in unbarked trees and timber?
2. Length of time spent by larva boring in the wood.
3. Length of time spent in the pupal state.
4. Length of life of imago.
5. Is there more than one generation in the year? If not, do the adults only issue during June and July, or do they issue irregularly between June and October?

THALESSA,
OR
RHYSSA SP.

Plate VII, fig. 2.

Reference :—Provisionally determined as above.

Classification :—Order, HYMENOPTERA. Family, Ichneumonidæ. Parasitic upon SIREX sp. and perhaps upon XYPHIDRIIDES.

Description.

♀. A fair-sized insect. Head black. Eyes black with a longitudinal oval orange mark on either side almost surrounding them. Antennæ long, filiform. Thorax black with yellow spots, wings membranous, yellowish, with black veins. Legs long, black, except coxa which is yellow, and trochanta which is yellow above and black beneath. Body black, shining, with a pink cerise spot on either side of each segment at the posterior edge. In dead dry specimens these spots are either a dirty yellow or pale greenish blue. The coxæ and trochantas are also blackish.

Length 1 inch. Length of ovipositor 1¼ to 1⅛ inches. (See Pl. VII, fig. 2.)

Life History.

This insect appears on the wing in June towards the beginning of the month, the time of emergence depending upon the elevation. I have only as yet found the perfect insect but under conditions such that I have no doubt that it is parasitic upon the *Sirex* sp. I have found them together plentifully in spruce trees, the smaller exit holes of the ichneumon being mixed up with the larger ones of the sirex. (See Pl. VII, fig. 1, f. The smaller holes and upper section of a gallery are those of the *Thalessa.*) Numerous dead ichneumons were also found both in the wood and bark, but under different conditions. Many of those in the wood were in borings which did not reach to the outside and were facing outwards, seeming to show that they had not been able to bore their way out, the larvæ which their grubs had infested and finally killed having gone too deep into the wood. When this latter happens the ichneumon fly is said to bore in the direction of the outside of the tree for a certain period and if it does not reach it within this time it gives up and dies, probably from exhaustion. The other adults found had apparently drilled a hole through the bark and in some cases a little way into the wood, by means of their saw-like ovipositors, until they reached a larval gallery in which they probably laid their eggs. The larvæ developing from these eggs probably feed upon the *Sirex* larvæ as external parasites. Dead insects were numerous in the tree, their ovipositors and portions of their bodies being often found in holes in the bark, the former being fixed in the wood whilst the upper portion of the body protruded from the bark. From examinations I was able to make of numbers of these, I am of opinion that it may be possible that the ichneumons die *in situ* after laying their last eggs either near or amongst the *Sirex* eggs or in the larval tunnels. It would also appear probable that instinct leads the Thalessa to lay its egg in the right place by enabling it to unerringly know where the larval tunnels and larvæ in the wood are. Without such knowledge it would seem impossible for the parasite, whose ovipositor is only 1½ inches in length, whilst the spruce bark is often over an inch in thickness, to reach the larval tunnels. I think this latter is very probably the case since the number of insects found in this position was considerable.

Locality from where reported.

This insect was found in the same locality as already given for *Sirex* sp.

Relations to the Forest.

This ichneumon is evidently of some utility since it helps to keep down the numbers of so serious a timber-boring pest as the *Sirex*. It does not prevent the damage being done to the actual tree in which it is found since it is probable that the larvæ reach a considerable size, or, in other words, do a very considerable amount of damage, before they succumb to the attacks of the ichneumon grubs. At the same time it does a small amount of damage to the wood itself since it has to bore its way out from the larval gallery where it has matured.

Points in the life history requiring further observation.

1. The number of eggs laid in each larval gallery and the age of the *Sirex* larva in whose gallery they (if more than one) are laid. Are the eggs only laid in very young larval galleries, or are older larvæ attacked?
2. The length of time spent in the larval state.
3. The length of time spent in the pupal stage.
4. Does more than one ichneumon grub attack any one *Sirex* larva?

CALLIRHYTIS SEMICARPIFOLIÆ,
CAMERON.

Plate VII, fig. 3, a, b, c.

Reference: —Cameron in litt.

Classification:—Order, HYMENOPTERA.

Tree attacked:—*Quercus semicarpifolia* (the Kharshu Oak).

Description.

The *larva* is a minute white grub. (See Pl. VII, fig. 3, a.)

The *pupa* is white and the parts of the perfect insect are seen nearly free, each covered in a very delicate skin. It is found simply lying in its cell and is unenclosed in any kind of silky cocoon. As the insect matures the head becomes black, as also the upper surface of the thorax and abdomen, the latter becoming pale yellow on the under surface.

Imago.—Head and antennæ black; upper parts of thorax and abdomen black, sides and ventral surface dark amber-yellow; legs amber-yellow and moderately long; body is ovate-elliptical and blunt at posterior end. Wings four in number 1½ times length of body. Expanse of wings $\frac{5}{16}$th inch. Pl. VII, fig. 3, b, shows the pupa and fig. 3, c, the imago of this insect.

Life History.

This insect was discovered by the writer in acorns on July 5th. It proves to be new to science. All stages of the insect from full-grown larvæ to fully mature imagos, and also pupæ, were present in the seeds. It may thus be taken that the fly reaches its full development during the first fortnight in July or just before the burst of the monsoon.

The pupal stage is evidently a very short one.

As far as present observation goes the species would appear to require a cold climate, since the elevation at which this oak grows is from 8,500 to 10,000 feet.

The tree flowers in July-August, and it would appear probable that the flies lay their eggs either in the female flowers or on the twigs adjacent to them, as the insect's life from the young larva to the fully developed fly is spent within the acorn. On maturing the imago bores its way out, a small hole on the outer surface of the seed showing the place of exit. This is all that is at present known of the life history of this pest.

Locality from which reported.

This insect was discovered in an oak forest near Baghi in the Bashahr State, Punjab, at an elevation of between 8,500 and 9,000 feet.

Relations to the Forest.

The acorns in a piece of pure Kharshu Oak (*Quercus semicarpifolia,* Smith) forest were badly attacked by this insect in 1901. Under the attack the acorns turned quite black and later dropped to the ground. Many were still on the trees on July 5th but came off quite easily in the hand. In most instances, beyond the colour and a certain shrivelled appearance, there was no external evidence of the attack upon the acorn, this proving that the insect was only just reaching maturity. In a few instances only a hole at the base of the seed, piercing through the calyx, showed where the perfect insect had escaped. Inside the acorn was found to consist of a mass of hymenopterous cells containing larvæ, pupæ or nearly mature and mature insects. In several instances on exposing these later to the air they at once flew off.

The attack of this insect and some lepidopterous allies (to be considered later) was most serious, as I estimated that fully 80 per cent. of the seed over the area inspected was infested, and it is not improbable that the percentage was higher.

Protection and Remedies.

Wholesale attacks of this nature to the seed of forest trees require the most careful study, since they are most intimately connected with regeneration of the areas. In the present instance further close observation is necessary to discover whether the pest is itself infested with insect or fungoid parasites.

I would suggest that over small areas, where feasible, when such a large proportion of the acorns are infested by pests of this nature, it would be a good plan to sweep up into heaps and burn all the fallen seeds. If this is done thoroughly it is true that the small proportion of good seed will be destroyed but along with it enormous numbers of larvæ, pupæ, etc., will be killed off: as a result, the eggs laid being so much fewer in number, in the following year there will be every chance of obtaining a large crop of good seed. This remedy, when it is applicable, could be usefully tried in the case of cones and other fruits the seed of which suffers under similar attacks. (See No. 1, p. 110 of these notes.)

Points in the life history requiring further observation.

1. When are the eggs laid by the fly and where? Is it in the flowers or on the twigs adjacent to them?
2. When the young larvæ hatch out of the eggs.
3. Length of time spent in the larval stage.
4. Length of time spent in the pupal stage.
5. Does the ♀, on leaving the acorn, at once pair and lay her eggs?
6. What parasites, insect and fungoid, attack this pest?

HETEROCEROUS ALLY OF C. SEMICARPIFOLIÆ, CAMERON.

Inside the black-coloured acorns attacked by the above described hymenopterous fly were also some small (probably micro-lepidopterous) caterpillars. These were of all sizes up to about ⅓rd inch in length and two different species were present—

(1) In colour whitish-translucent, with blackish-green head, and a small partial collar of the same colour on the top of the dorsal surface of the first segment.

(2) Small brownish hairy larvæ, about ¼th inch in length, with numerous short tufts of hair with long hairs interspersed amongst them. (See Pl. VII, fig. 4.)

These larvæ appeared to be burrowing within the acorn amongst the hymenopterous cells. Both hymenopterous and lepidopterous larvæ were cut out of the nut practically alongside one another.

Owing to constant shifting of camp I failed to breed out any of the moths from these caterpillars. It is not improbable that the larvæ pupate in the soil after the acorn has dropped to the ground.

We have still to observe, with reference to these insects, where the eggs are laid, how long the larvæ spend in the larval stage, where they pupate, and when the moths appear. Until the latter are found the insects cannot of course be named.

OTHER HETEROCEROUS LARVÆ ATTACKING THE ACORNS OF QUERCUS SEMICARPIFOLIÆ.

Description of larvæ.

Three different kinds of caterpillars appeared to be present, all differing in appearance, two markedly so, from those already described as accompanying *Callirhytis semicarpifoliæ*:

No. 1. Whitish-translucent with markings similar to the one already described ((1) above) but the grub was much larger, being ½ inch in length. This *may* prove to be the same as one of the two found with *C. semicarpifoliæ*.

No. 2. This differed totally in appearance. Yellowish-red in colour, with a black head and a row of blackish tubercles down each side situated above the median plane. Length ½ inch.

No. 3. A larger caterpillar, ¾ inch in length, differed in appearance from the above both in size and colouration, etc., though I considered it might be only in a more developed stage. It was dark brown and hairy on its dorsal surface, yellow on its ventral one, with a yellow head and thoracic segments. Dorsally it was covered with numerous tubercles bearing tufts of brown hair; running down each side, were a row of orange-coloured tubercles bearing shortish tufts of hairs of the same colour together with pencils of long, fine, yellow hair.

Life History, etc.

The above-described larvæ were cut out of acorns which were not infested by the hymenopterous fly.

Nos. 1 and 2.—The acorns from which these were taken were reaching normal size, being roundish in contour and green, touched with red on one cheek. They had holes on their outer surfaces and within I found as many as three larvæ feeding on their contents. Never more than three were found and sometimes only two.

No. 3.—This was cut out of an acorn which had turned dark brown in colour. It was feeding in the interior.

This is as far as observations on these caterpillars have been carried at present. Unfortunately, though an attempt was made, no moths were successfully reared from the larvæ.

From the holes visible on the outer surfaces of the green acorns, it is probable that at least one of the larvæ wanders about during this stage of its existence and enters the acorns from the outside. In no instance was any trace of the hymenopterous fly found in acorns attacked by these three larvæ. If No. 1 is the same as the caterpillar (1) accompanying Callirhytis, its development would appear to be quicker when infesting acorns free from the fly. Further observation is required on this point.

Points in the life history requiring further observation.

1. Where are the eggs laid and when?
2. Length of time spent in the larval stage by the various caterpillars.
3. Where they pupate (is it in the ground after the acorn has fallen from the tree?), and length of time passed in the pupal stage.
4. When the various moths issue and period spent in this stage.[1]

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[1] I should be much obliged if specimens of these moths, when procured, were sent to me to Dehra Dun.

A further note on the life history of SINOXYLON CRASSUM, LESNE.

(*See pp. 12-15 in No. 1 of these Notes.*)

Trees attacked :—*Shorea robusta* (Sâl); *Terminalia tomentosa*, Roxb.

Description.

The beetle varies greatly in size. Specimens taken in the Dehra Dun sâl forests are as much as $\frac{5}{16}$th of an inch (7·8 millim.) in length.

Life History.

This insect has been found boring into sâl shoots and seedlings by students Littlewood and B. C. Gupta.[1] The insect was found in the beetle stage in the third week in February, and examination showed me that it was egg-laying. It bores a large circular entrance hole into the wood and then mines up the shoot. The shoots infested were dead ones at the end of the branches of sâl poles, and the beetles were plentiful. Student Littlewood made the following note: "The beetles were found in little bores in the dead upper part of young sâl shoots; almost every shoot was bored into, the entrance hole being usually above a node and the gallery proceeding downwards. Beetles found in the Phandowalla sâl areas."

The beetle has not previously been reported as commencing the first egg-laying of the year before April. The fact that it begins work so much earlier in the year in the Dun forests and that it is of so much larger size would appear to be of some importance, and its life history in these forests requires working out.

Owing to its large size, I was doubtful of its identity with *S. crassum*. Mr. Lesne, who settled this point for me, tells me that he has already had it reported as infesting the sâl, but does not mention from where the insect was sent.

S. crassum was also found infesting the *Terminalia tomentosa* last year in the Central Provinces.

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[1] Of the Imperial Forest School, Dehra Dun.

Terminalia tomentosa is a tree of some value in parts of India. In the Central Provinces it is in demand for rafters etc., used in the construction of bungalows. Whilst in Seoni, in August last year, my attention was drawn to the state of the roofs in some newly-built bungalows put up by the Bengal-Nagpur Railway. They had the ordinary thatched roof so common in the country, the rafters, carrying the superstructure of bamboos and thatching grass, consisting of roughly-barked *Terminalia tomentosa* posts. These latter were being badly riddled by the Sinoxylon beetle which was egg-laying, the floor and furniture beneath being covered with little yellow spots of saw-dust dropping from the beetle borings. Mr. C. O. Hanson, the Deputy Conservator in charge of the Seoni Division, who was my companion at the time, informed me that most, if not all, of the roofs of the new bungalows were in a similar state, some being very bad indeed. One of these latter I was subsequently shown, and the number of beetles at work in the roof was very large. Through the courtesy of the railway officials, Mr. Hanson was able to send me up one of the attacked posts taken from this roof the following month (September). The post was sent up in lengths, together with some insects cut from a portion of it. Amongst these were some *S. crassum* beetles. The insect was egg-laying in September, both beetles and half-grown larvæ being found in tunnels in the wood. Under favourable circumstances, some of these larvæ develop into beetles, which issue about the beginning of November and hibernate as such through the cold-weather, or a portion of the cold-weather, months.

Protection and Remedies.

Bostrichids of this kind do not infest green living trees, nor will they attack fresh-cut posts immediately after felling. As soon, however, as the sap has begun to dry off a little from the post, the bostrichids make their appearance and commence boring into the wood for egg-laying purposes. It is immaterial, in the case of these beetles, whether the pole is barked or not, as it is the wood, and not the bast layer, which they require. It is during the drying stage, therefore, whilst chemical changes are taking place in the wood, that posts require protection, and although the matter is at present, I believe, little understood, it has been discovered that if the posts are kept in water after being cut whilst these changes in their interiors are taking place, their liability to attack by bostrichid beetles is apparently enormously decreased. My studies in this matter, as far as they have at present been carried, lead me to believe that this is not infrequently an undoubted fact, both in the case of wood and bamboos.

I therefore recommend that, whenever possible, poles (and bamboos), when cut, should be—

(1) Felled (preferably) when the sap is down.

(2) As soon as cut, placed in water, and kept there for some time.

(3) If the latter is not possible, smoked as soon after felling as possible.

Locality from where reported.

The insect was found at Phandowalla in the eastern Dun forests of the United Provinces; elevation about 2,000 feet. It was also obtained at Seoni in the Central Provinces.

A further note on the life history of SINOXYLON ANALE,

LESNE.

(See pp. 16-18 and Pl. I, fig. 2, of No. 1 of these Notes.)

Plant attacked—Bamboo.

Dehra Dun, United Provinces, must now be added to the area of distribution over which this beetle ranges. It was discovered in October 1901 in tunnels in bamboo tent poles in the store-room at the Imperial Forest School, Dehra Dun.

I am not aware that the beetle has been previously reported as infesting bamboos.

Protection.—I would recommend that, when tents are put away after the camping season is over, a plentiful supply of naphthaline (in lumps, not powder) be packed in amongst the folds, and that pieces be placed in the heaps of stacked tent poles. This will have the effect of keeping away other pests affecting the canvas in addition to keeping the poles free of borers.

DINODERUS PILIFRONS,
LESNE.
THE BAMBOO BORER.

Plate VIII, fig. 1, a, b.

References:—Lesne, Ann. Soc. Ent. Fr. (1895). Stebbing, Injur. Ins. Ind. For., 42—45. Fig. 26.[1]

Classification:—Order, COLEOPTERA. Family, Bostrichidæ. Sub-family, Dinoderinæ.

Plants attacked:—*Dendrocalamus strictus* and probably other bamboos.

Description.

I add the following to the short description of this beetle given on page 43 of *Injurious Insects:*

Beetle.—Long oblong, parallel, reddish brown with the appendages and lateral edges of the abdomen lighter in colour. Long reddish hairs near the eyes and on the clypeus (lower portion of front part of head). The upper part of the antennæ has the same hairs. The teeth on the anterior surface of the prothorax are more or less pointed and projecting. Punctation on the elytra fine anteriorly, becoming much stronger at the posterior declivity.

Length $3\frac{1}{8}$ to $3\frac{3}{4}$ millim. (See Pl. VIII, fig. 1, a.)

Life History.

This insect is one of the several small bamboo-borers of India. It infests the bamboo (*Dendrocalamus strictus*) in the Siwalik forests. This bamboo grows in clumps and is often seen to have towards its base the contorted shape shown in Pl. VIII, fig. 1, b. This may be due to congestion in the clumps, but the matter has not been satisfactorily explained as yet. Some pieces of bamboo contorted in this manner were cut green at the beginning of February and placed in a breeding box towards the end of the next month. By July the box was an inch deep in bamboo saw-dust amongst which were enormous numbers of the *Dinoderus pilifrons* beetles, which had bored their way out of the bamboos. On examination larvæ were found in the bamboos, which were very much riddled. (See fig. 1, b.) Many of the insects were left in the box with the bamboos and continued breeding and egg-laying until November, in which month there were many mature beetles still alive in the bamboos and at the bottom of the box.

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[1] Given as Dinoderus sp. Since named by Mons. Lesne as *Dinoderus pilifrons*.

From the above it becomes evident that this insect has several generations during the year, and my present observations lead me to the conclusion that these generations probably overlap, and that consequently beetles are to be found, with the exception of the colder months, December to March, throughout the year.

That the beetle lays an enormous number of eggs and has the power of very rapid multiplication is evidenced by the very large number of insects bred out from the few small pieces of bamboos placed in the breeding cage.

Localities from where reported.

Mysore and Dehra Dun (N.-W. India) and the adjacent forests are the localities from which the insect has been especially reported as doing damage. M. Lesne gives the distribution of the insect as India, China and the Philippines, Bangkok (Dr. Hammond), Belgaon (H. E. Andrewes).

Relations to the Forest.

This beetle and a closely allied species, ***D. minutus***, are serious pests of bamboos in India. As long as the bamboo is green and healthy it is apparently unattacked, but if through any cause it becomes sickly whilst still standing in the clump or as soon as it is cut, the beetles attack and lay their eggs in it. There is no doubt that the duration of the life of the cut bamboo for building and other purposes is greatly shortened all over the country by the operations of this pest.

The natives have many superstitions with reference to these insects, the one most generally believed in being that bamboos should not be cut at full moon and when they are full of sap.

The Madras Board of Revenue instituted enquiries on these heads in 1898, and a series of interesting experiments were made by the Department in that Presidency. The evidence on some points is conflicting and this was to be expected since the conditions under which the bamboos were experimented with were not the same in all cases. The concensus of opinion of the majority would seem, however, to favour cutting bamboos in the winter months, *i.e.*, November to March when the sap is low. Bamboos cut in the spring or summer suffer very seriously from the borers, as also do newly-cut ones kept in the shade. This statement is considered to apply to newly-cut poles also. Whilst there can be no doubt that there is a good deal to be said for these theories, the point should not be lost sight of that at present we know very little about the life histories of these borers. It is known that there is more than one species (and more than one genus) of beetle which attacks the bamboos. One or more of these may hibernate in the wood through the winter months either as a larva or beetle, commencing the first attacks of the year on neighbouring bamboos towards the end of March. This being the case it may follow that bamboos cut between December and the middle of March, containing as they do little sap, may rapidly dry and thus, besides becoming distasteful to some of the borers, at the same time by contraction kill off the hibernating insects within them. I would suggest that it is not so much the phases of the moon, etc., which require to be studied but rather the life histories of the beetles.

My experiments with the Dun bamboos would seem to show that the beetles, having once got into the stems, continue boring and breeding in them throughout the spring and summer months or at any rate that this is the procedure of *Dinoderus pilifrons*. Other species may perhaps leave the bamboo when quite dry.

Protection.

1. Whenever possible bamboos as soon as cut should be immersed for a few weeks in water. It is an undoubted fact that they then become less liable to attack from wood-borers. The reasons are threefold :—

(1) Whilst submerged the beetles cannot get at the bamboos to attack and lay eggs in them.

(2) Any beetles and larvæ that may be at work in them will be drowned.

(3) It is considered that the water dissolves out much of the nutritive matter in the wood cells, upon which the borers and their larvæ feed.

2. In thinning bamboo clumps in the systematic manner now carried out in parts of India, the contractor should be made to remove, as far as possible, the larger refuse from the cut-over clumps. It is usual to remove only the straight pieces of any one bamboo cut out, these alone having a marketable value. The rest is left lying *in situ*. The thin branchwood stuff would probably be too expensive to either remove or burn, but the thicker rejected tops and ends should be cleared out of the forest. If they are thrown into the nearest stream it will suffice. It is more than probable that the systematic working of the bamboo clumps, whereby the formerly large amount of dead and dying bamboos in the forest, which always provided a sufficiency of food for the beetle, is disappearing, will bring the pest into prominence, by localising it in centres and thus rendering it dangerous, if the larger refuse is left round the thinned clumps in the coupes.

3. Cut bamboos in the cold weather months, preferably between December and the end of February, since there is the greater probability of the borers being in the hibernating stage of their life history during these months.

Points in the life history requiring further observation.

1. The number of generations of the insect in the year.
2. Length of time spent in the larval and pupal stages of the insect in the various generations.
3. What other trees are attacked by this *Dinoderus* ?

DINODERUS MINUTUS,

FABR.

References:—Fabricius, 1775, Syst. Ent., p. 54—Olivier, 1790, Enc. méth., Ins., V, p. 111.—Id., 1795, Ent., IV. No. 77, p. 15, pl. II, f. 12. *substriatus* Stephens, 1830, Ill. Brit. Ent. III, p. 352. *siculus* Baudi, 1873, Berl. Ent. Zeit., XVII, p. 356.—Id. 1873, Ann. Mus. Gen., 1873, p. 265; *bifoveolatus* Zoufal (*non* Wollaston), 1894, Wien. Ent. Zeit., XIII, p. 42. Lesne, Ann. Soc. Ent. Fr. LXVI, pp. 329—334 (1897).

Classification:—Order, **COLEOPTERA**. Family, **Bostrichidæ**. Sub-Family, **Dinoderinæ**.

Plant attacked:—Bamboos (sp.?).

Description.

Beetle.—Slightly elongated, brown, with the lower dorsal portions of the elytra lighter coloured, occasionally almost reddish. The stiff hairs on the front portion of the clypeus always few in number and very short. 10-jointed antennæ, the upper portions not fringed with hair; the second joint of the club less than one and a half times as large as long. Front edge of the prothorax armed with more or less pointed teeth, not set very close together, the middle ones being more gaping than the outer. Posterior portion of the pronotum strongly and thickly punctate (pitted), but the pits do not join. Elytra covered with short bristly hairs becoming denser on their posterior declivity. Elytra are thickly and densely pitted, more deeply so on their anterior portions. This beetle is very like the one shown in Pl. VIII, fig. 1, a, but is smaller.

Life History.

This insect has been so often confused with its close ally *Dinoderus pilifrons* that it is impossible to say with any certainty what its life history really is. It undoubtedly infests bamboos in great numbers and not improbably often works in company with its companion. This has, however, to be yet observed. It was not present amongst the *D. pilifrons* bred out of the bamboos obtained in the Siwalik forests. It is apparently very common in the Bombay Presidency where it is said to be plentiful in houses from December to February flying slowly about (H. E. Andrewes). There should therefore be no great difficulty in working out its life history in that Presidency. This is of some importance since it may turn out that bamboos are subject to the attacks of the borers throughout the year on the Bombay side if *Dinoderus pilifrons and D. minutus* are equally plentiful. It has been found boring into bamboo in Guadaloupe, in the dry roots of *Smilax borbonica* in the Island of Réunion and in lianas from Brazil in which cotton had been packed.

Localities from where reported.

Lesne states that this beetle is cosmopolitan in tropical regions. It is the commonest species of the genus and is at times found in ports and large towns in temperate climates.

As I have said, Andrewes reported it as very common in the Bombay Presidency.

Relations to the Forest, etc.

The same remarks apply as given for *D. pilifrons.*

The remarks with reference to the best time for cutting may require modification in Bombay for this beetle. It is not possible to make any definite statement, however, until its life history has been worked out.

Points in the life history requiring further observation.

1. The number of generations in the year. Since the beetle is found on the wing from December to February, during the colder months, and since it has such a wide spread, it is not improbable that the number of life cycles passed through in a year are very large.
2. Length of time spent in the various stages of egg, larva, pupa and beetle in the different life cycles.
3. The different food-plants of the insect.
4. Does the beetle attack sickly still-green trees, etc., or does it only infest dry dead plants?

BOSTRICHUS PARALLELUS,

LESNE.

Plate VIII, fig. 2.

Reference:—Lesne, Ann. Soc. Ent. de France, LXIII, 170 (1894).

Classification:—Order, COLEOPTERA. Family, Bostrichidæ.

Plant attacked:—*Dendrocalamus strictus* (Bamboo).

Description.

Beetle.—Black, shining, somewhat narrow, elongated, with parallel sides. The joints of the antennæ from 3—7 taken together are longer than the first and second united. The dorsal surface of the elytra is strongly punctated, the punctations being disposed in a regular series of striæ. The sides of the prothorax and elytra covered with a stiff pubescence, which is not thick. Ventral surface of the body densely pubescent. In the ♂ the posterior declivity of the elytra is fairly highly punctured. In the ♀ the forehead is not convex; the declivity of the elytra has not projecting edges.

Length 9·13 millim. (See Pl. VIII, fig. 2.)

Life History.

This beetle was found in the middle of June boring into dead stacked bamboos. It was in the imago stage, and was probably egg-laying. It was cut from the wood tissue.

Locality from where reported.

The beetle was sent from Raipur, Central Provinces, by the late Mr. A. M. Long, then in charge of the forests at that place. The insect has a very wide distribution, as M. Lesne gives the following as its geographical distribution: Indo-China, Hindustan, Formosa, Sumatra, Philippines.

Relations to the Forests, etc.

These are much the same as already given for the two species of *Dinoderus* beetles already described. With reference to this beetle, it is necessary to discover whether it infests bamboos as soon as cut or whether it only attacks already dead ones.

Points in the life history requiring further observation.

1. Method of egg-laying and number of eggs laid.
2. Length of time spent in the larval and pupal stages.
3. The length of time spent as a beetle.
4. The number of generations in the year. In all probability, this will be more than one, perhaps several.
5. The condition of the bamboos when attacked by the beetle, whether green or absolutely dry.
6. The other food-plants of the beetle.

PLATEROS DISPALLENS,

WLK.

Classification:—Order, **COLEOPTERA.** Family, **Malacodermidæ.** Sub-Family, **Lycides.**

Tree attacked:—*Tectona grandis*, L. (Teak).

Description.

Egg.—Dirty pale yellow in colour and elliptical in shape. Very small.

Beetle.—Head and prothorax shining black. Prothorax entirely covers the head, wider than long, with a deep sinus running round its edge. Antennæ longish, serrate, and shining black, as also are legs; elytra soft, leathery, not meeting rigidly at the suture; rounded at ends. Anterior half of elytra orange yellow, posterior portion black. Under-surface of insect shining black. ♂ resembles ♀ in colouration, but latter is slightly larger Length ½ inch when fresh. Pl. VIII, fig. 3, shows the ♂ and ♀ of *Plateros* sp., to which this one is very similar in appearance.

Life History.

The insect is to be found on the wing in the middle of August, about which time it pairs. The eggs appear to be laid very soon after pairing, as beetles kept under observation laid within 24 hours of coupling. The eggs are laid in batches of irregular shape, from 30 to 35 being deposited close together in a batch. The eggs were not laid upon the teak leaves placed in the tube with them, but on the sides of the tube. It is not improbable that they may be laid upon the teak twigs in the forest or round and on the buds. This point requires further observation. *Plateros dispallens* frequents teak forests at this time of the year and does a certain amount of surface defoliation to the leaves. So far my observations have shown me that it eats patches out of the parenchyma of the upper surface of the teak leaves; as a consequence, the lower untouched portion of the leaf dies and turns brown.

Locality from where reported.

This insect is at times common in parts of the Damoh forests in the Central Provinces.

Relations to the Forest.

From our present slight knowledge of the habits of this Plateros it is impossible to say whether the damage it is capable of doing in the forest is considerable or otherwise. A certain amount of leaf tissue is lost under its attacks as already stated, but present observations have not shown that this loss is sufficiently heavy to materially affect the health of the tree.

Points in the life history requiring further observation.

1. Where the eggs are laid. Is it on the teak leaves or twigs?
2. When and where does the larva hatch out and on what does it feed?
3. Length of time spent in the larval stage.
4. Length of time spent in the pupal stage.
5. Number of generations in the year.

PLATEROS SP.

Plate VIII, fig. 3.

Reference:—Provisionally determined as *Plateros* sp. new to the British Museum Collection.

Classification:—Order, COLEÓPTERA. Family, Malacodermidæ. Sub-Family, Lycides.

Tree attacked :—*Tectona grandis*, L. (Teak.)

Description.

This beetle differs from *P. dispallens* in both size and colouration.

Egg.—Pure white in colour and egg-shaped resembling a minature hen's egg. Slightly larger than that of *P. dispallens.*

Beetle.—General colour is a reddish-orange beneath and a russet brown on head and thorax dorsally. Anterior two-thirds (basal portion) of the elytra, which resemble in consistency and formation those of its smaller companion, russet-brown in colour, the posterior third being black at tips shading off anteriorly into the russet-brown colour. Legs black, tinged with russet-brown. Antennæ longish, serrate, black. Two segments of the body project beyond the elytra. ♂ smaller than ♀.

Length of ♂ ⅓ inch; of ♀ ½ inch (measurements of fresh specimens). Pl. VIII, fig. 3 shows a dorsal and side view of the ♂ and ♀ of this insect.

Life History, etc.

The notes on the life history, locality where found, etc., already given for *Plateros dispallens,* apply equally to this beetle. The insects were found on the teak leaves in company and both the species were coupling. The eggs are laid shortly after coupling in a similar manner to those of its companion, the numbers laid being from 35—40 deposited in irregular patches. The insects readily take to flight on being disturbed.

The further observations on the life history required for the one are the same for the other.

HALTICIDES.

Plate VIII, fig. 4.

Reference:—Provisionally determined as belonging to the *Halticides.* not in the British Museum Collection.

Classification:—Order, COLEOPTERA. Family, Chrysomelidæ.

Tree attacked:—*Boswellia serrata.*

Description.

Beetle.—A medium-sized thick set insect with small yellow head and two prominent black eyes. Thorax yellow, slightly broader than long, small. Elytra broader than thorax, yellow to brownish in colour, the yellow being generally in irregularly-shaped faint blotches. At times a few faintly marked black spots are present. In the ♀ the elytra are sometimes all yellow with scattered brownish markings and small spots. The elytra are broadly striated with rows of punctures between the striæ and are deflexed posteriorly leaving one segment of the body exposed. The body is thick and pointed posteriorly, yellow to yellow brown beneath and shining. Antennæ and legs canary yellow, the former being slender and short. Posterior pair of legs are long and have their femora (thighs) remarkably thickened and developed, thus enabling the insect to leap the great distances it is capable of doing. These femora are at times dark yellow to brown in colour. The posterior tibiæ are spined at their bases. The third tarsal joint is deeply bilobed.

Length ♂ $\frac{5}{16}$ths inch; ♀ $\frac{3}{8}$ths inch. Pl. VIII, fig 4. shows a dorsal and side view of this Chrysomelid.

Life History.

This beetle appears on the wing at the beginning of August and possibly during the latter part of July.

It feeds upon the leaves of *Boswellia serrata.* These leaves are compound ones, and it apparently attacks the upper leaflets, first feeding downwards until about two-thirds of the compound leaf (from top downwards) has been more or less eaten away.

At other times all the leaflets disappear entirely. The beetle begins by eating the leaflet irregularly round the edge, patches being gnawed out, or it commences on the inner part and eats out holes in the leaf tissue. The effect of this defoliation is to cause the leaflets to shrivel up, turn brown and fall off.

At the beginning of August, when these beetles were observed at work, the insects were pairing; the male, the smaller insect of the two, being carried about on the back of the female. This Chrysomelid is a powerful jumper, and even when coupled the ♀ will often take a long leap. Like many *Chrysomelidæ* they are extremely wary and take to flight at the slightest motion which alarms them. If too late to fly, they drop off the food-plant like a stone and sham death on the ground, where, owing to a similitude in colouring, they are extremely difficult to see. When coupled, they appear to lose some of their extreme wariness.

At present I have no further observations on the life history of this pest.

Locality from where reported.

This insect was found in the Bhamburda Reserve near Poona in the Bombay Presidency.

Relations to the Forest.

I have described above the manner of feeding of this Chrysomelid. There can be no doubt that when in any numbers it is capable of doing a large amount of defoliating damage. We do not yet know where its larval stage is passed or upon what the grub feeds.

Protection and Remedies.

When feasible in nurseries and young plantations, this beetle can be attacked in its adult stage by means of the Paris green arsenic treatment described on pages 146—149 of these notes (No. 1). The beetle, being a leaf-feeder, will take the poison internally and be killed off. We require to know more about its life history, however, as it may prove easier to attack it in its grub stage.

Points in the life history requiring further observation.

1. When the eggs are laid.
2. When and where the grubs hatch out and on what they feed. Length of time spent in this stage.
3. Length of time spent in the pupal stage and where this stage is passed.
4. Number of generations in the year.
5. What other, if any, trees and plants this beetle feeds upon. This is important since the beetle is a fair-sized one and active, and consequently if it made its appearance in the large central nursery recently formed near Poona, it would not unlikely commit considerable havoc amongst the young plants.

STROMATIUM BARBATUM,

FABR.

THE KULSI TEAK BORER.

References :—Fabr. Syst. Ent. p. 189. Stebbing, Inj. Ins. Ind. For. 73-76, figs. 48 (larva), 49 (imago).

Classification :—Order, COLEOPTERA. Family, Cerambycidæ. Sub-Family, Cerambycides.

Tree attacked :—*Dendrocalamus strictus* (Bamboo).

In *Injurious Insects* this insect has already been reported as attacking teak and khair.

Description.

Larva—Is a whitish thick grub with a pale brown prothorax larger in breadth than the rest of the segments. The mouth parts are black.

Beetle—Has a general brown to brownish colour and is covered with a moderately dense orange yellow pubescence. Eyes kidney-shaped, the antennæ being inserted forwardly on the head in the angle in the eye. Antennæ long slender, basal joint being thickened and black; other joints brown and set with a longitudinal row of stiff hairs on the under-surface of the joints. Prothorax is broader than the head, wider than long, with irregular-shaped swellings and knobs on its dorsal surface. Laterally on either side there is an ear-shaped depression filled with densely set hairs which are a bright orange yellow in male, a dull purple in ♀. Legs longish and slender, the tarsi being clothed with yellow hairs. Elytra long, of the same width as the thorax from which they are separated by a small neck; rounded at their ends and broadly striated and pitted in longitudinal rows on their dorsal surfaces.

♂. Antennæ stout, longer than body. Length 1 inch.

♀. Antennæ not as long as body, more slender than in ♂. Portion of the last abdominal segment projects beyond the tips of elytra. Length a little over 1 inch.

Life History.

I have already described what is known of the life history of this insect in *Injurious Insects.* It is known as the Kulsi Teak borer, and has proved destructive to young teak saplings at the Kulsi Teak Plantation, Assam. It was also reported as attacking dry khair (*Acacia catechu*) wood in the Forest School Museum, Dehra Dun. In this latter case the eggs were probably laid in the bark of green wood, and the young larvæ then bored into the tree and remained boring in the wood after it had been sent to the Museum, as it is known that they spend more than one year in this stage of their life history.

The beetle is now reported as having issued from dry bamboos in the Raipur Division, Central Provinces. In this case also it is probable that the eggs were laid in the green bamboos soon after they were cut.

Relations to the Forest.

This pest is known as a dangerous one in Teak plantations in parts of India. The fact that it also attacks bamboos would tend to show that it has several food plants, and it becomes important to fully work out its life history.

Points in the life history requiring further observation.

1. Length of time spent by the larva in this stage. As larvæ of various sizes (and ages) are to be found at all times of the year in infested stems, it is certain that the grub lives for more than one year in this stage.
2. The different kinds of trees infested by the insect and the age at which the tree is attacked.

MYLLOCERUS ACACIÆ, MS.

Plate VIII, fig. 5.

Reference :—Provisionally named as **Myllocerus acaciæ, MS.** new to the British Museum collection.

Classification :—Order, **COLEOPTERA.** Family, **Curculionidæ.**

Tree attacked :—*Acacia Catechu.*

Description.

Beetle.—A greyish oblong weevil clothed above and below with short fine golden yellow hairs. Proboscis or rostrum not quite as long as broad, thick and slightly enlarged at its tip. Scrobes (the groover on the proboscis) deep and easily seen from above and in front. Antennæ placed anteriorly on proboscis near its tip, long, and clothed with short yellow hairs. Scape of antenna (basal portion of antenna below elbow) thickens anteriorly; funiculus (upper portion above elbow) with first two joints long and equal, third to seventh joint short; club oval-oblong and jointed. Eyes large. Prothorax broader behind than in front; scutellum small. Elytra almost flat in front, convex behind, deflexed to a point at their tips; are set with parallel longitudinal rows of fine punctures running down them. Femora thickened; third joint of tarsus bilobed and all joints set with a fine pubescence. Second abdominal ventral segment wider than the succeeding ones and separated from the first by a suture which is arched in the middle. Length ¼ inch. Insect winged and flies well. (See Pl. VIII, fig 5.)

Life History.

This weevil was noticed feeding upon, and defoliating to a certain extent, the leaves of *Acacia Catechu.* The insect apparently only feeds upon the young green leaflets. The compound new leaves of this tree were at the time, the beginning of August, half unfolded, and it was then that the weevil was engaged in its defoliating operations.

The insect did not appear to be pairing, and consequently the attack had possibly only just commenced. At the time of my inspection the damage done was but small.

I know nothing more about the life history of this beetle, which is quite different from the species described on p. 31 (No. 1) of these notes as defoliating the Sissu.

Locality from where reported.

The insect was found in the Bharuburda Reserve near Poona in the Bombay Presidency.

Relations to the Forest.

As I have described, this ***Myllocerus*** in its adult stage does a certain amount of defoliation. Further than this, nothing appears to be known about the weevil. When and where it lays its eggs, where the larva lives and on what it feeds and the time spent in this stage have yet to be observed. Also the number of generations in the year and how the cold weather is passed.

Note.—A second minute bright metallic-green ***Myllocerus,*** the species being as yet undetermined, was also found in company with the ***M. acaciæ*** MS. above described feeding upon the leaves of the *Acacia Catechu.* The insect was somewhat plentiful, but owing to its small size, about ⅛th inch in length, the damage done by it was inappreciable. This weevil was pairing at the time of capture.

CYPHICERUS SP.

Plate VIII, fig. 6.

Reference :—Provisionally named **Cyphicerus** sp. not in the British Museum Collection.

Classification :—Order, **COLEOPTERA**. Family, **Curculionidæ**.

Tree attacked :—*Tectona grandis*, Lin. (Teak).

Description.

Beetle.—♀. General colour brown with blackish head and thorax. Insect covered more or less with short stiff hairs. Rostrum not longer than head. Antennæ inserted near top; scrobes short and deep. The antennæ are not inserted right at top of rostrum in ♀ (they are so in ♂) but a little way down it; are set with hair: scape thick, thickening anteriorly, slightly arched; funiculus with first joint short, second nearly twice as long, third to seventh short and the club oval-oblong and pointed at its extremity and jointed. Eyes large, only slightly convex, oval-oblong, oblique. Prothorax rather narrow, straight in front and behind. Elytra oblong-oval, wider than prothorax, widening posteriorly and deflexed at their apices which meet in a point; brown in colour with a dull white transverse band in their posterior third; longitudinal parallel series of striæ and punctures run down the elytra. Legs moderately long, thighs thickened and ending in a little spine beneath; tarsus very hairy beneath, third joint much broader than first and second. Body oblong, ♂ more yellow in colour without the white transverse patch on elytra and with the golden short stiff hairs much thicker on elytra. Antennæ inserted at top of rostrum. Length ♂ $\frac{8}{16}$th inch; ♀ ¼th inch.

Pl. VIII, fig. 6, shows a dorsal and side view of this insect.

Life History.

This insect appears on the wing in Berar in July, probably generally about the time the monsoon bursts. It feeds upon the leaves of the teak tree. Either the life of the beetle is a somewhat lengthy one or the eggs develop at irregular periods since a month later the weevils were found common in the Damoh forests in the Central Provinces.

In Berar the beetles were noticed pairing on July 26th, the insects being very numerous on the teak trees, both young and old being infested.

In the middle of August the weevils were found in a similar condition in the Damoh forests. On the 20th of the month I noted the beetle as equally numerous in the Jubbulpore Division between Jubbulpore and Lucknеedown. Here, as in the portions of Damoh visited, the beetle was far more plentiful during this month than either of the teak leaf defoliators, *Hyblæa puera* or *Pyrausta machæralis*, which were present with it on the trees.

In Berar (in the Melghat forest) the weevil had an additional companion in the larva of the hawk moth *Pseudosphinx discistriga* and was in parts very much more abundant than the latter, although it was not noted as ascending quite so high into the hills as the sphinx. In these forests both the latter and the weevil were much more abundant than the *Hyblæa* and *Pyrausta*. Its method of defoliation is as equally distinct from that of the hawk moth (described in No. 1, p. 52 of these notes) as from that of the *Hyblæa* and *Pyrausta* (described later on in this number). The weevil attacks the leaf in two ways: either by eating out patches from somewhere within the leaf, avoiding the edges, so that the leaf becomes full of irregular-shaped holes, the larger veins being always left untouched, or it eats out irregular portions from the edges, the latter having thus a ragged and frayed appearance. In both cases the edge left by this beetle always has this frayed and ragged appearance owing presumably to the very small portions of leaf tissue it is able to take out at a time in the case of so thick a leaf as the teak leaf. The patches eaten out by this weevil can thus be easily distinguished from those of a caterpillar attack since the latter's bite when it goes through the leaf is always a clean cut: a frayed edge is never left. So marked is this jagged appearance of the leaves that it caught the eye and told me of the presence of the beetle as I was riding along a road in Damoh bordered with teak trees before I had been into a forest in that district.

Neither the eggs nor larvæ of this pest have yet been found.

Locality from where reported.

The writer found this weevil common at the lower elevations in the Melghat teak forests lying between Ellichpur and Chikalda; in the Damoh Division between Damoh and Singrampur; between the latter place and Jubbulpore; and between Jubbulpore and Luckneedown on the Jubbulpore-Nagpur road.

Relations to the Forest.

While this weevil undoubtedly does a certain amount of defoliation on the teak in years when it is plentiful, attacking the leaves of both young and old trees, present observation does not show it to be anything like as bad a pest as its three lepidopterous companions, and it appears doubtful as to whether it would ever be capable of entirely denuding a teak forest of its leaves. It must, however, certainly be considered an enemy of the tree, and it is important that the rest of its life history should be worked out, especially the point as to where its larva lives and on what it feeds.

Protection and Remedies.

In nurseries spraying young plants attacked with the Paris green arsenical solution would have the effect of killing off the beetle. This should be done as soon as the pest makes its appearance, and repeated at intervals through July and August. The earlier the beetles are attacked, the less chance is there of their reaching the pairing stage and laying eggs.

Points in the life history requiring further observation.

1. Where the eggs are laid.
2. Where the larva lives and upon what it feeds.
3. Length of time spent in the larval stage.
4. Where does the larva pupate?
5. The number of generations in the year. Are there one or more spring (hot weather) generations and a late autumn one as in the case of its companions *Hyblæa* and *Pyrausta*?
6. Where and in which stage of its metamorphosis does it pass through the cold weather?

APODERUS INCANA, MS.

Plate VIII, fig. 7, *a—c*.

Reference :—Provisionally named **Apoderus incana, MS.** new to the British Museum collection.

Classification :—Order, **COLEOPTERA.** Family, **Curculionidæ**

Trees attacked :—***Quercus incana*** and ***Q. dilatata.***

Description.

The *egg* is yellow, shining, elliptical in shape and about $\frac{1}{16}$th inch in length.

♀ The *beetle* is small, shining, dark yellow brown with black markings on the elytra. Rostrum brown, short, broad, and armed at end with a pair of large mandibles. Antennæ inserted near base, the scape short and inverted cone-shaped; funiculus fairly long, first joint small, second and third longer and of equal length and with the following ones increasing in breadth upwards to the elongated cone-shaped club which is dark brown, the rest of antenna being yellow. Head short, semi-elliptical in shape narrowing to a point posteriorly, dark yellow-brown in colour. Prothorax joined to head by a short neck widening posteriorly and having a raised collar where it joins the elytra. Scutellum small, black. Elytra much broader than thorax, a little longer than broad, widening slightly to their ends and deflexed here, only lightly covering the body and leaving portions of two segments of the abdomen exposed; yellow in colour, channelled at their bases with two elongated black spots in their basal half; the external edge is raised and thickened slightly all round and is crimson to dark red in colour, being especially bright at the suture. Abdomen thick, lighter yellow ventrally. Legs bright yellow, long, with their femora thickened; 2 claws to end of tarsus. Length $\frac{9}{32}$nd inch. Pl. VIII, fig. 7, shows a dorsal and side view of this beetle.

Life History. [1]

These beetles appear on the wing about the close of the first week in May. At present only the perfect beetle is known. The insect when found was egg-laying and for this purpose it attacks the leaves of both the oaks, *Quercus incana* and *Q. dilatata.*

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[1] The curious method of egg-laying of this insect was studied by Mr. F. Gleadow, Ranger Subramarian, and by the writer in May 1901.

The ♀ beetle lays its egg in the left-hand corner of the apex of the leaf. The latter is then, in the case of the *Quercus incana,* either cut across two-thirds of the way down the leaf, the cut being made on both sides from the exterior edge horizontally inwards till it meets the midrib, or the leaf is cut right across from one side to very near the edge of the other, a small piece of the leaf tissue only being left. In either case the portion above the cut is folded inwards down the midrib and then rolled up from the apex downwards, the outer edges being tucked in so as to form a neat little cylinder which remains suspended to the lower part of the leaf by the uncut portion. (See fig. 7, b, c.) This latter is however, whether midrib or leaf tissue, nicked across so as to ensure the little roll of leaf tissue dropping to the ground when it has become dry. In the case of the *Quercus dilatata* the procedure is much the same except that the leaf appears to be almost invariably cut lower down (fig. 7, c.).

The little leaf rolls soon turn black as the tissue decays and are then very conspicuous upon the trees. It is probable that a small white or yellow curved grub hatches out of the egg and feeds upon the decaying leaf tissue of the roll, and subsequently when this latter has fallen to the ground, burrows into the earth to pupate. This part of the life history has, however, yet to be studied.[1]

The insects may be observed egg-laying for about three weeks during May, but the number of eggs laid by each female has yet to be ascertained.

Locality from where reported.

Throughout Jaunsar Bawar and the adjacent Native States of Tehri-Garhwal, Jubal and Balsan this insect was very plentiful in 1901.

Relations to the Forest.

The peculiar method of laying its eggs adopted by this insect results in the trees attacked being very heavily defoliated when the weevil is numerous. Trees of all ages are infested, and it is the new just unfolded leaves which are primarily treated in this manner, the older ones being only resorted to after the newer ones have been all occupied. Pl. VIII, fig. 7, *b*, shows a portion of a branch with the upper leaves defoliated by this insect.

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[1] Compare the life history of the species of *Apoderus* attacking the Sissu (*Dalbergia Sissoo*) tree described in No. 1, pp. 33, 34 of these notes.

In 1901 the insect was very plentiful and large numbers of the leaves of the two oaks were treated in this way. The insect was less plentiful during the present year. In 1896 Mr. Gamble, at the time Director of the Imperial Forest School at Dehra Dun, sent some of the attacked leaves with the little rolls attached to the Indian Museum, Calcutta, with a request to be informed, if possible, as to what insect acted in this manner. This letter was referred back to myself in January 1901 by the late Mr. L. de Nicèville with a note asking whether I could let him know what insect acted in this peculiar manner and for what reason.

Protection and Remedies.

These will be the same as already given on p. 36 of these notes for the Sissu Apoderus.

Points in the life history requiring further observation.

1. The number of eggs laid by each ♀.
2. The food of the ♀.
3. Does the larva eat anything besides the little leaf roll prepared for it by the ♀?
4. Length of time spent in the larval stage.
5. Length of time spent in the pupal stage.
6. Is there more than one generation in the year, *i.e.*, is the summer flush of leaves attacked in a similar manner?

Note.—In the same locality beetles of the genus *Apoderus* have been found rolling up the leaves of the wild pear (*Prunus Padus*) and the larger ones of the Himalayan Hazel (*Corylus colurna*) both towards the end of May.

In the middle of August a species of *Apoderus* was taken from teak leaves in Damoh in the Central Provinces, but I am unable to say whether it cut out and rolled up portions of teak leaves in egg-laying, or whether it laid its eggs on some other tree [1].

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[1] Since this note went to press the writer has found several other species of *Apoderus* in the North and South Coimbatore forests in Madras. These were laying their eggs in and rolling up the leaves (and consequently defoliating the trees) of *Grewia tiliæfolia*, *Anogeissus latifolia*, etc. These insects will be treated of in a subsequent number of these notes.

CYRTOTRACHELUS LONGIPES.[1]

Plate IX, fig. *a—h*.

Reference:—Curculio longipes. Fabr. Ent. Syst. Tom. I. 395.

Classification:—Order, COLEOPTERA. Family, Curculionidæ.

Plant attacked:—***Melocanna bambusoides*** (Muli Bamboo).

Description.

The *eggs* are elliptical in shape, whitish in colour, and about $\frac{8}{32}$nd inch in length (see Pl. IX, a).

The *larva* is described as a large whitish legless curved grub with slight fleshy tubercles on the underside of the body. It is shown on Pl. IX, b.

The *pupa* is white in colour and has the ordinary weevil shape.

The *beetle* is a large shining rufous-ferruginous coloured insect with a black patch on the thorax and black longitudinal patches on the sides of the elytra and another black longitudinal one running down the median suture of the elytra. The insect has a longish thick rostrum and long legs.

♂ Rostrum long, thick, straight, quadrangular, deeper than wide at its base and dilated and truncate at its tip, furnished on its upper surface with two lateral rows of tubercles; scrobe short, placed laterally. Mandibles thick. Antennæ fairly long and stout; scape arched backwards slightly; second joint of funiculus slightly longer than others; club fairly large, triangular, with apex at outer end; pubescent on outer surface. Prothorax slightly longer than broad, convex, smooth and shining, rounded at sides, narrowing ventrally and having a

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[1] This insect was found attacking the muli bamboo in the Chittagong Division by Mr. J. P. Gregson, Extra-Assistant Conservator of Forests, Bengal, and its life history was worked out by him in 1899. During 1900, whilst holding charge of the division, I made frequent observations on the attack, going carefully through the stages of the life history with Mr. Gregson. I was thus able to corroborate his careful and excellent observations.

circular raised collar at its dorsal anterior edge which is produced laterally on either side. Elytra longer than thorax, narrowing behind and finely but distinctly striated, the intervals between the striæ being fairly broad. Looked at superficially the upper integument appears to be without punctures. Legs long, thick and flattened; the front ones larger than the hind but only slightly so than the middle pair; femora thickened; tibiæ, more especially the anterior ones, ciliated on their inner edge and arched at their extremities and prolonged into a curved stout spine; tarsus long, the first joint longer than the second, the third heart-shaped; the segment of the body exposed by the elytra (pygidium) triangular, convex, and ending in a point posteriorly. Body oblong-elliptical, glabrous.

♀ much larger than ♂ with a longer rostrum. Front legs much larger than either of the hinder pairs, their tibiæ being very thickly ciliated on their inner edges. Pygidium blunter at posterior extremity than in ♂. Length ♂ 1⅜th inch; ♀ 1¾th inch (to end of rostrum in each case). Length of rostrum in ♂ $\frac{7}{16}$th inch; in ♀ ½ inch. (See Pl. IX, c, d.)

Life History.

The beetles appear on the wing during the latter part of May or beginning of June at about the time the monsoon rains burst over the Chittagong Hill Tracts. They pair soon after emergence, and the ♀ then seeks out young sprouting bamboos in which to lay her eggs such as that figured in Pl. IX, e. Shoots attacked are always under 3′ in height. The insect grasps the fleshy shoot, generally about 3 inches below the top, with her long front legs, and cutting an oval incision in it through the outer spathe just above an internode with her lengthy proboscis deposits two eggs at its base, covering them over with bamboo chips which are of the same colour. These eggs, which can be seen *in situ* from the outside, have been observed to be laid towards the end of June though as the beetles are to be found through July and on to about the middle of August, it is not improbable that the ♀ lays other eggs on adjacent shoots. As far as present observations show, it is, however, apparent that only one of the eggs comes to anything, as only one larva is to be found in any one attacked shoot. Dying shoots are common at the beginning of July, and numbers were examined by Mr. Gregson in 1899, and again by him and by myself in 1900. The larva, on hatching out, probably bores through the tissue horizontally until it reaches the centre of the shoot and then invariably bores downwards, eating away the soft central portion and increasing in size at a rapid rate. It continues feeding downwards until it reaches the base of the shoot, by which time it is full fed. The grub then retreats back up its gallery, probably enlarging the upper portions, which will be now too small for it until it reaches about the place it started from. It then cuts this portion off, gnawing it through all round below him (see Pl. IX, f). The top drops to the ground, and the now fully mature larva burrows into the soft rain-loosened earth, carrying the top or a portion of it with him, thus completely sheltering itself from atmospheric influences. Larvæ in various stages of growth are to be found in the shoots in the middle of July, and they mostly become full-grown by the end of the month. About the middle of August young shoots are to be seen on all sides with their tops fallen and in a dying or dead condition. The larva changes to the pupal state within the fallen buried end of the shoot at a depth of 3 to 4 inches, or even more, below the surface of the ground, the depth depending upon the consistency of the soil. The top of the shoot soon rots, only the harder fibres persisting (see Pl. IX, g, h). Inside this fibrous covering, which is generally caked with earth, the pupa remains during the following cold and hot seasons, emerging as a beetle at the commencement of the ensuing rains. The warm rain moistens the ground and thus softens the pupal 'case,' the fibres of which will only require wetting to crumble to dust after the heating up they have undergone during the hot months of the year, even in the shadier portions of the forest. The beetle then doubtless pushes its way out and makes its way up through the subsoil and humus. In the case of a specimen kept I noted that the beetle when ready to emerge gnawed its way out of its fibrous covering cutting a hole at one side (see Pl. IX, g). It will be seen that the pupa is thus safeguarded against enemies, since its covering resembles nothing so much as a decaying lump of vegetation mixed with earth mould. From the above account it becomes apparent that some ten months of the insect's life history are passed in the pupal stage, about 5 weeks in the imago and egg-laying stage (excluding the period the insects remain alive after egg-laying, which period requires further observation to ascertain definitely the number of eggs laid by the beetle) and three to four weeks in the larval or destructive stage.

Locality from where reported.

This weevil is plentiful in the Chittagong Hill Tracts in the bamboo jungles adjacent to the Karnafuli river.

It has also been reported from the Cape of Good Hope.

Relations to the Forest.

C. longipes has proved a most serious pest to the *Melocanna bambusoides* bamboo killing off young shoots over a fairly wide area both in 1899 and 1900. In these years large numbers of young bamboo shoots were observed springing up in the forests at the commencement of the rains. By August some 30 to 40 per cent. on areas inspected round Kaptai and elsewhere had been killed off, in the damper localities the attack being even more severe. The infestation appeared to diminish as the moister localities near the river were left behind, and almost disappeared as one went up the slopes of the hills. I am of opinion that the severity of the attack was probably due to the great clearance made in the portions of the forest which lay in the path of the great cyclone of October 1897 which swept up into the Hill Tracts from the Bay of Bengal, destroying some valuable teak plantations near Kaptai and laying low most of the trees it met with far up into the hills. As a result of this clearance of large tree growth in the forest, the muli bamboo commenced to shoot up in dense masses during the rains of 1898, and this was followed by the heavy and localized attacks of the beetles in 1899 and 1900. I have no information as to whether they were continued the following year, as I was unable to visit the area in question.

Mr. Gregson states in his note that shady places under thick growth are preferred to others. By this I understand him to mean thick *undergrowth* in moist places, not high forest. In such places the shoots undoubtedly come up thickly and are most succulent, and as such are doubtless preferred by the beetles for egg-laying.

Protection and Remedies.

In the case of plantations the most obvious remedy is to collect the female beetles when egg-laying; a surer method, dig up the pupal cases and burn them. A better remedy, however, and one which would be practicable over larger areas would be to collect all the fallen and evidently attacked tops, each of which contains, as we have seen, a larva, and burn them. This done carefully would do a great deal towards stamping out the attack.

Points in the life history requiring further observation.

Owing to Mr. Gregson's excellent observations, these, as far as is at present known, would appear to be few.

1. The number of eggs laid by the ♀. This is a very important point, and would be easily discoverable were some beetles obtained as soon as they issued in June and kept in a box with fresh bamboo shoots, each shoot upon which eggs had been laid being removed.
2. What other species, if any, of bamboo are attacked by this beetle.

RHYNCHOLUS SP.

Plate X, fig. 1, a, b.

Reference :—Provisionally determined as *Rhyncholus* sp. new to the Britis Museum Collection.

Classification :—Order, **COLEOPTERA.** Family, Cossonidæ.

Trees attacked :—*Pinus excelsa* (Blue Pine), *Picea Morinda* (Spruce) and perhaps *Cedrus Deodara* (Deodar).

Description.

I have as yet only found the beetle.

Beetle.—Long, narrow, black, shining, with elbowed antennæ, the club of antenna being pale yellow and tibiæ and tarsus rufous-brown with reddish yellow hairs. Head large; rostrum not longer than head, stout, cylindrical, slightly depressed downwards; scrobes narrow, starting near centre of rostrum and oblique. Antennæ start from lower half of rostrum, short, fairly stout; scape club-shaped at upper end; funiculus 7-jointed, 1st joint long, 2nd to 7th very short, increasing in size upwards; club smallish, oblong-oval, 1st joint long and reversed cone-shaped; others short, spongy, pale yellow in colour. Eyes medium sized, oval. Prothorax long, slightly conical and rounded on sides, truncate at upper and basal ends, with a slightly transverse depression just below the upper edge. Scutellum very small. Elytra long, cylindrical, slightly flattened, slightly wider than prothorax behind, depressed behind, and projecting down laterally below the abdomen towards their extremities on either side, the extremities being pointed and having a crescent-shaped interval between them, the points of the elytra forming the outer horns of the crescent. The elytra bulge laterally on either side into a small projecting point just before the depression commences. Legs short, femora thickened in middle and flat, arched beneath; tibiæ straight, flattened, and toothed at their base; tarsus short, filiform; 3rd joint not longer than the others and not bilobed; 4th long with small claws. Intercoxal joint large and rounded anteriorly. Body long parallel, and more or less cylindrical, thickening to a certain extent posteriorly. Rostrum, head, prothorax, and body above and below thickly punctured, the punctures being lighter on dorsal surface of head. Elytra channelled by longitudinal, deep, striæ, and punctured. Length $\frac{5}{32}$nd to $\frac{3}{16}$th inch. (See Pl. X, fig. 1, a.)

Life History.

This beetle is a wood-borer, and appears on the wing in the spring about the second week in May, from which date it may be found till the end of June in considerable quantities boring into the wood of blue pine and spruce to lay its eggs. I am of opinion that the beetles found during these six weeks are those of one and the same generation, which is probably the first one of the year. I am at present unable to say whether there is another generation, or more than one, at a later period in the year. The beetles of the May-June generation attack the trees in swarms, and may be found at this period either in or beneath the bark, or on or in the sapwood. They bore either horizontally or at an angle into the dead bark of the standing tree, and, on reaching the sapwood, either continue their burrow into it or more usually move about for a time between the sapwood and bark cutting a long groove in the latter before going into the wood. Having selected a suitable spot, they then bore into the sapwood usually at an angle. This tunnel is carried for about 1 inch or less into the wood, and the insect then turns and burrows up the long axis of the tree for as much as a couple of inches. The eggs appear to be laid at the end of this long gallery. The latter is not always straight, but may bend yet again and go further into the solid wood. Pl. X, fig. 1, b (1) shows a curved boring of this beetle.

I have not yet found larvæ, and am not at present aware how they feed.

Localities from which reported.

The insect was first found in 1901 in dead blue pine at Kathian, Jaunsar Division, North-West Himalayas. The following year it was found plentifully in blue pine and spruce at elevations of between 5,500 and 7,500 feet in the same division.

Relations to the Forest.

The information on the life history of this beetle is at present too meagre to enable its relation to the trees it attacks to be definitely stated. That it is capable of swarming in large numbers has been ascertained, and the value of the wood attacked is considerably diminished by the tunnelling work of the insect Whether, however, the injury it is capable of doing is confined to this or no, I am unable to say. It is often to be found in company with the *Hylastes* sp. described below.

Points in the life history of the insect requiring further observation.

1. How the eggs are laid and when and how the larva feeds.
2. Length of time spent in the larval and pupal stages.
3. What becomes of the mother beetle after laying her eggs?
4. The number of generations passed through by the insect in the year.
5. Does the beetle confine itself to attacking dead wood, and does it infest other trees than blue pine and spruce?

Rhyncholus sp. in deodar.

NOTE.—At the end of June I obtained some specimens of a *Rhyncholus* probably closely allied to, if not the same insect as, the above. It was discovered boring into the wood of a newly felled deodar tree in company with a species of *Platypodæ*.

HYLASTES SP.

Plate X, fig. 2, a, b.

Reference:—Provisionally named *Hylastes sp.* new to the British Museum collection.

Classification:—Order, COLEOPTERA. Family, Scolytidæ.' Sub-Family, Tomicini.

Trees attacked:—*Pinus excelsa* (Blue pine), *Picea Morinda* (spruce).

Description.

Beetle—Cylindrical, black, and shining. Head prolonged into a short broad rostrum held vertically downwards and slightly less broad than the head. Antennæ inserted near the extremity of the rostrum in a deep socket. Antennæ elbowed, the scape long and terminating in an oblong oval thickening; funiculus with 7 joints, the first and second long, thick, the others shorter, with a short oval club consisting of four articulations and yellow in colour. Longish oval eyes with the antennal edge entire. Prothorax not broader than long. Scutellum very small and triangular. Beetle thickens out posteriorly both horizontally and vertically. Elytra long, cylindrical, their rounded apices forming the posterior declivity; strongly striate and punctate. Tibiæ fairly large and with a toothed serration on their outer edge. Third tarsal joint not longer than the others.

The male beetle is slightly smaller than the female. Pl. X, fig. 2, a, shows a dorsal and side view of this insect.

Length of ♀ beetle ⅛th inch.

Life History.

This beetle tunnels into the heart-wood of blue pine and spruce. The insect enters the tree from outside by boring a tunnel, which may go horizontally into the wood (in standing trees) or may be at an angle. On reaching the wood, they usually mine out a gallery at an angle to their entrance one. This latter tunnel may be straight or may wind about [see Pl. X fig. 2, b (1)]. Towards its extremity on either side short galleries at right angles to the previous one are eaten out and the eggs laid in them [see Pl. X, fig. 2, b (2)].

I have not yet found the larvæ.

The beetle is to be found egg-laying from the second week in May to the middle of June, this being probably the first generation of the year. Observation is still required to find out whether there are any subsequent generations in the year.

The male and female pair during the above period, and they perform this act within the tree in the tunnel. I am unable at present to say which of the two bores the tunnel, but the first portion of it as far as the pairing place is the work of one beetle only. The subsequent boring is the work of the ♀.

The ♂ climbs on to the back of the ♀ to fertilize her.

Locality from where reported.

This insect was found in the blue pine and spruce forests of the Jaunsar Division, North-West Himalayas, at elevations of between 5,500 and 7,500 feet.

Relations to the Forest.

Present observation of the habits of this beetle has only shown it to be a wood-borer, and the wood is apparently only infested when the tree is nearly or quite dead. The insect has at present always been found associated with the *Rynchotus* sp. in spruce and blue pine, but it is by no means so numerous. It bores farther into the wood than the latter, reaching the heart of the tree. Its life history requires to be more fully worked out before its full relations to the trees it attacks can be ascertained.

Points in the life history requiring further observation.

1. How the larvæ feed, and length of time spent in this stage.
2. Length of time spent in the pupal stage.
3. What becomes of the mother beetle after laying her eggs.
4. The number of generations passed through by the insect in the year.
5. Does the beetle attack green wood, and does it infest other trees besides the blue pine and spruce.

A further note on the life history of

SCOLYTUS MAJOR, MS.

Plate XI.

References:—Provisionally named *Scolytus major*, MS. *Scolytus* sp. See No. 1 of these Notes, pp. 45—48, and Pl. IV, fig. 4, *a*, *b*, *c*.

Tree attacked:—*Cedrus Deodara* (Deodar).

This beetle infests trees of all ages from the largest to quite young saplings. In these latter it is to be found near the base of the stem. It is therefore always found in company with the smaller Scolytus, *Scolytus minor*, MS., being only absent in the tops of young saplings. In poles and saplings, when possible, it enters the tree beneath a branch as described below in the case of its smaller companion. Failing branches, it chooses some flake of bark or inequality on the stem and burrows beneath it. It is generally the more numerous of the two beetles.

The number of developing eggs is between 60 and 70. At times the number may be more or less. The first eggs laid by the beetle hatch out before it has finished the egg gallery, the time passed in the egg stage being probably from 4 to 7 days.

The *egg* is spherical in shape, yellow in colour and shining. It is wrapped up in what appears to be filamentous wood shavings.

The *larva*, on first hatching out, is a minute little white dot. The curved shape is, however, easily recognizable by the time it has bored about ¼ inch away from the egg gallery. The larval life of the first generation is about 4 weeks from leaving the egg to pupation.

Pupation takes place partly in the wood and partly in the bark except in the case of the smaller saplings, when it may occasionally take place entirely in the wood, the larva boring into the sapwood at or near the end of its gallery. The larva pupates about the last week in June.

Plate XI shows a complete plan of the galleries made by this insect: *a a a* is the egg gallery, *b b*... are the larval galleries, *c c*...the enlarged pupating chamber in the wood at the end of the larval tunnel.

The *pupa* is white and has the ordinary beetle form, the legs, antennæ, and wings being free and folded close on the breast.

The beetle does not die when it has finished egg-laying, but is to be found in the egg gallery or entrance hole until the larvæ are full grown (in the case of the first generation). I have not yet ascertained how long after this period it remains alive. When the mother beetles die, they do so in the entrance holes, the posterior end of the abdomen protruding from, or being close to, the exterior opening of the entrance hole. In this way predaceous insects are prevented from entering the egg gallery which, together with the entrance hole, is kept quite free of wood dust.

The young beetles on maturing bore a horizontal tunnel to the outside of the tree and escape.

Relations to the Forest.

The further study I have been able to make on the life history of this beetle has shown that it is a most dangerous pest, since it will attack the largest deodar trees. It evidently prefers freshly-felled timber, failing which it attacks sickly trees and on occasions, undoubtedly, green saplings. The point to draw attention to here, however, is its preference for freshly-felled trees. In some deodar fellings inspected towards the end of June (1902) the cut trees lying on the ground still unconverted were covered, in the instances examined, from top to base between the bark and wood with galleries of this and the smaller Scolytus containing mature larvæ, the mother beetles being in most cases still alive. (Plate XI shows a portion of a pole attacked in this way). The trees had been felled at the end of April and beginning of May just about the time the beetles of the last generation of last year (1901) were issuing to lay the eggs of the first generation of the present one. These eggs were deposited in the bark of the felled timber in bole, top, and large branches. From measurements taken at the time I have made the following calculation :—

The cut portion of a tree measured had a diameter of 3 feet at base, 10 inches at top (a length of 16 feet had broken off in the fall and is taken separately), and a length of 90 feet. On every portion of 1′ × 1′ there were on an average 23 beetle galleries, *i.e.*, egg galleries. Now I have shown that between 60 and 70 eggs of the larger Scolytus and between 40 and 50 of the smaller one hatch out into larvæ which tunnel into the wood, and that the larger beetle is more numerous than the smaller, in this case in the proportion of 15 to 8 on the areas taken.

Therefore on every 1′ × 1′ of surface of bole we have—
Egg galleries of larger Scolytus
× hatched out larvæ . = 15 × 60 = 900
Do. smaller do. = 8 × 40 = 320

giving a total of 1,220 hatched out eggs per 1′ × 1′, or multiplied by 44·5, the number of 1′ × 1′ surface pieces in the bole, a total of 54,000 larvæ.

The 9″ × 2″ × 16′ of top gave another 2,300 larvæ.

The larger branches were much broken in the fall of the tree in most cases, and their contents, for they were covered with the *Scolytus* egg and larval galleries, may be taken as a set-off to attacks of predaceous insects on the above and over estimate of larvæ hatching out from the eggs. We are left with a total of 56,300 beetles, the product of the first generation of the year raised in a single tree, capable of producing 40 to 60 larvæ a piece for the second generation of the year. If we only take 50 per cent. of these as arriving at maturity and safely passing through the winter, the increase of beetles from one single tree is still enormous, the calculation coming roughly to 1,550,000 beetles. It should be noted here that if the trees are felled in spots reached by the midday sun, it will be found that the beetles will attack the portion of the bole nearest the ground and its sides only, leaving untouched the upper surface, the bark of which, exposed to the full sun's rays, will dry very rapidly and will in consequence be unsuitable for their purpose. In such cases the tree will not raise so many beetles as in the case above quoted. We have now to consider another important point. If fellings are still being carried out towards the end of July and in August, the beetles of the first generation will lay in the felled trees, but should the cutting operations have ceased, the Scolytus will search out and attack sickly trees. There are always such in a forest—trees whose vitality has been lessened for the moment either by fires, drought, or attacks of defoliating insects and aphids. With time such trees would, in many cases, recover but the bark beetles, taking advantage of their reduced vitality, attack and kill them.

In the case of some young trees examined with Mr. Oliver he drew my attention to a white fungus near the base of the tree. Dr. Butler, who has examined it, says it is a species of *Trametes*, and would undoubtedly cause the death of the tree. In many cases I have, however, found young dead trees with the sapwood scored from top to base (see Pl. X, fig. 3, d) with the galleries of this Scolytus beetle and its companion *S. minor*, MS., whilst there was no trace of fungus present. In such cases *S. major* confines itself to the lower part of the young tree. Knowing as we do that neither of the beetles will lay their eggs in bark which is not absolutely fresh, we can but consider that the ultimate cause of death of these young trees was due to the bast layer having been entirely consumed by the beetles.

Protection and Remedies.

In the previous number of these notes such have been already considered for this beetle. I would, however, here add one important recommendation.

If possible, all trees should be barked as soon as felled, and a clause to this effect should, I suggest, be entered in the contractor's agreement. It will not be necessary to burn the bark. If it is exposed inside uppermost to the sun, the grubs and pupæ will be killed. So long as trees felled at the periods the insect is intent on egg-laying are left lying in the forest unbarked, the pest will continue to increase rapidly and the results can hardly be other than most serious to existing growth. Immunity from serious attacks of this and other pests has been due to the fact that the forests have always contained an abundant supply of food material for them. As this becomes curtailed, the pests, if allowed and, unknowingly, aided to increase, will become a most formidable danger.

SCOLYTUS MINOR, MS.

Plate X, fig. 3, a, b, c, d; Plate XI, d.

Reference:—This beetle is new to the British Museum collections. I have provisionally named it *Scolytus minor*, *MS.*, to distinguish it from its larger companion which I call *Scolytus major*, *MS.*

Classification:—Order, **COLEOPTERA.** Family, **Scolytidæ.** Sub-Family, **Scolytini.**

Tree attacked :—*Cedrus Deodara* (Deodar).

Description.

The *larva* is a small white curved legless grub with a yellow head. Length 2·2 millim. (See Pl. X, fig. 3, a.)

The *pupa* is white resembling the beetle in shape with its legs, antennæ and wings lying against the breast of the insect, each enclosed in a thin membrane. (See Pl. X, fig. 3, b.)

The *beetle* has a great resemblance to the one already described as *Scolytus* sp. in these notes (No. 1, page 45), and which I now call *Scolytus major*, MS., but is considerably smaller. It is black, shining, cylindrical, legs brown to blackish and antennæ and tarsi rufous brown. Head not covered over by the prothorax, and with a broad rostrum. Antenna short, angled, the scape enlarged at the end; funiculus 7-jointed, 1st and 2nd joint long, 3rd to 7th only slightly increasing in size upwards; club longer than funiculus. Eyes narrow and long. Prothorax convex, longer than broad, sparingly punctured, the punctures being smaller and weaker on the anterior portion, which is very shining. Scutellum triangular. Elytra slightly longer than prothorax, punctured, but both here and on the prothorax the punctures appear to be more irregularly distributed than in the larger species above mentioned. Abdomen cylindrical; under-surface is flexed upwards at the posterior end. Length 2·5 to 2·8 millim. A reference to Pl. X, fig. 3, c, will show what this insect is like.

Life History.

At elevations of between 6,000 and 7,000 feet, this beetle's flight time is about the last week of April or the beginning of May.

At higher elevations, round 8,000 feet at the upper limit of deodar growth, it apparently first appears about the middle to the third week of the latter month. The beetle is to be found beneath the bark in all parts of the deodar trees, bole, top and side branches and in trees of all ages from the largest in the forest to small six-foot saplings. The insect invariably accompanies *Scolytus major*, MS., and it is only in the smallest saplings or the smaller branches of trees that it is found alone.

The beetle's method of attack from the outside and its operations within the tree are constant and are easily recognizable. As is usual with bark-borers, it bores a small 'shot hole' through the bark in order to reach the bast, and in saplings and poles this is always made on the main stem just beneath a branch at its point of junction with the stem. The main branches of a deodar are more or less horizontal, and the beetle takes advantage of the shelter thus afforded it to carry on its operations protected from the view of its foes, and more especially from the predaceous *Clerus* beetle to be described later. In cases of bad attacks when every nook beneath the branches is already occupied two holes instead of one will be occasionally seen in this position, but this is exceptional. Failing a branch, the beetle seeks out any inequality on the stem such as a small projecting flake of bark or small ridge to make its entrance tunnel beneath. In large trees it always bores in beneath a flake of thick bark, and the entrance tunnel is usually at an angle. Only very exceptionally in the case of this smaller *Scolytus* have I found its entrance hole without some kind of shelter over it. On reaching the cambium layer the beetle, which apparently pairs with the ♂ before entering the tree as I have never found more than one insect in any one tunnel, commences to bore its egg gallery in an upward direction, circling round the branch in doing so, in order to get immediately above it and then going vertically up the main stem in small curved zig-zags (see Pl. X fig. 3, *d* (1)). If the gallery is made in side branches, it will be in the direction of the longitudinal axis of the branch. On either side of this egg gallery the beetle gnaws out little indentations in the wood and places an egg in each. These notches do not begin until the egg gallery has been bored for a short distance, the portion left free of them varying in length according to the length of the egg gallery, but they are always made right up to its extreme end, *i.e.*, the beetle ceases boring as soon as she has laid her last egg. As the *Scolytus* carries on her gallery, she shovels back the wood-dust with her feet, a large quantity of it being also apparently passed through the alimentary canal since round masses of chewed wood are constantly being passed out at the anus. These are apparently covered with some siccable substance and are detached by, and remain fixed for a time to, the hind tarsus. They may contain an egg and be placed by the tarsus into one of the recesses. My observations have not been sufficiently extended, however, to enable me to make this statement definitely at present. When the beetle has finished its egg-laying, it does not die, as is the case with many bark-beetles, but remains in the gallery or entrance hole, both of which are kept absolutely free of wood-dust, etc. If dust be pushed into this, she at once begins to shovel it out and get the tunnel clear again. In this the *Scolytus* differs from the blue pine Tomicus, which dies at the end of its egg gallery as soon as all the eggs are laid. I have found the *Scolytus* still alive in the tunnel when most of the larvæ from the eggs laid by her have become full-grown and one or two changed to pupæ. This is probably with a view to protecting the egg and larva from predaceous insects, as, when the ♀ dies, she does so in her entrance hole, the top of the abdomen being generally visible from outside, and thus effectually blocks it up. It does not, however, prevent the flat pink *Clerus* larvæ from getting to her offspring as the former move about between the bark and sapwood with ease. The eggs would appear to take but a few days to develop since those at the bottom of the tunnel, *i.e.*, those first laid, hatch out into young larvæ before the mother beetle has finished boring the egg gallery and laying the eggs higher up. Between 40 and 50 larvæ hatch out, but the number is at times fewer.

The grubs bore away from the mother gallery in a direction which in the middle of the tunnel is at right angles to it, and trends away from the right angle in an upward direction above and in a downward one below the centre (see Pl. X, fig. 3, d (2)). A uniform and almost invariably constant pattern is thus obtained, which, as the borings both of beetle and larvæ go down into the sapwood as well as up into the bark, remains indelibly impressed on them (see Pl. X, fig. 3, d, and Pl. XI, d).

When full fed, the larva bores a small pupating chamber half in the sapwood and half in the bark, and pupates within it. In saplings the pupating chamber is bored at times entirely in the wood at a little distance from the end or at the end itself of the larval gallery (see Pl. X, fig. 3, d(3)). The beetle on maturing bores its way out of the tree by a horizontal tunnel to the outside.

The mother gallery of this small *Scolytus* is from ¾ths to 2½ inches in length (Pl. X, fig. 3, d, and Pl. XI, d), though it may be even shorter, and, as I have said, is composed of a series of continuous short zig-zag curves. The larval galleries branching off from this are about 1¾ to 2¼ inches in length and increase in breadth as they get further and further away from the main gallery. The egg galleries made in the bole of large trees are usually shorter than those made in their branches or in saplings and small poles.

The beetles which appear in May are those of the overwintering stage, having hibernated through the winter either as larvæ or beetles, and they lay the eggs of the first generation of the year. About a month is spent in the larval state at the higher elevations, the grubs which hatch out during the last week in May becoming full grown in the last week in June. The beetles from these issue in July.

I have not at present any notes on the further life history of the pest, but as the latter is up to this period identical with that of its companion, *Scolytus major*, it will probably be found to run through a second generation before the close of the year (see No. 1, p. 45).

Locality from where reported.

This beetle was discovered by the writer in 1901 in the Jaunsar Bawar and Tehri Garhwal deodar forests of the Jaunsar Division in the United Provinces.

Relations to the Forest.

From the descriptions given of its habits it is evident that this insect is capable of proving a serious pest to the deodar the more so as its attacks are almost invariably accompanied by the large *Scolytus.* I have seen numbers of young deodar saplings with the sapwood covered from top to base with the galleries of the beetle. A young sapling which has been treated in this way is shown in Pl. X, fig. 3, d. If the tree is older, the galleries at the base will be those of the larger species. The insect will not touch dead bark or dead trees since it requires the green cambium layer in which to lay its eggs. Sickly trees near an infected centre will however be at once attacked, and there can be no doubt that such trees are killed by the beetle in cases where they might have otherwise recovered from their temporary feebleness. When very numerous, the insect undoubtedly attacks young green trees.

A pest of this kind is to be seriously feared in areas of young pure deodar growth, as its attacks in a plantation of such would ruin the work of years. It is for this reason that its full life history requires to be most carefully worked out, and more especially the question as to the number of generations in the year settled.

Protection and Remedies.

Infected centres should be cut clean out and the saplings carefully burnt unless it is found easier to bark them, when the bark should be exposed to the sun inside uppermost. The ground round the roots should be removed for about 6 inches and the sapling cut at this level and not above ground, or some of the beetles will be left in the portion of the tree remaining above ground and escape to carry on the infection. The management of deodar woods is becoming more intense in the country, and pests of this nature will require the most careful attention. Up to the present they have found plenty of diseased and dying trees to breed in. Under systematic working these are disappearing, and the struggle for existence will send the beetles to young and valuable saplings in the young newly-formed plantations or newly-planted up areas.

At Konain and Kathian in Jaunsar-Bawar, and at Deota in the Tehri-Garhwal forests, there are infected centres of this insect. I should recommend that careful search be made in these and other deodar areas and all attacked trees be treated as above detailed.

I inspected some fellings being made in the forests round Pajidhar and found that large trees cut in the spring, *i.e.*, in May, were covered from head to foot with the borings of this and the larger *Scolytus* beetle. Both main bole and all the branches were infested with the pests and in every case the galleries contained full grown larvæ. In other words, the trees as soon as felled had been attacked by a swarm of the *Scolytus* beetles. In a further note on the *Scolytus major* I have given a rough calculation, from measurements and countings made, of what this means in increase of beetles per tree per year (see p. 205).

If it be possible, I recommend that in future all deodar trees felled between the middle of April and middle of August should be at once barked. Exposing the bark to the sun's rays will be sufficient to kill all larvæ and pupæ present. A standing order that all deodar trees felled are to be immediately barked will be the simplest means of putting an end to this aid to the ncrease of these beetles.

2. All infested young saplings should at once be cut out and barked or burnt.

Points in the life history requiring further observation.

1. The number of generations in the year. This is a most important point. It probably varies with the elevation.
2. The length of time spent in the various stages of the metamorphosis of the succeeding generations.
3. In what stage and where the insect hibernates through the winter.

Some Natural Enemies of *Scolytus major* and *S. minor*, beetles.

CLERUS SP.

Plate X, fig. 4, a, b. Also see Pl. IV, fig. 5 (larva) in No. 1.

Reference:—Provisionally determined as *Clerus* sp.

Classification:—Order, COLEOPTERA. Family, Cleridæ.

Predaceous upon—

1. Bark Borers—
   Scolytus major and *minor*, MS.; *Tomicus* sp.; *Polygraphus major* and *minor*, MS.; *Pityogenes coniferæ*, MS.
2. Wood Borers—
   Diapus impressus, or close ally; *Platypus* or *Diapus* sp.; *Rhyncholus* sp.; *Hylastes* sp.

Description.

Larva.—General colour, a bright pink. Head brown, flat. Mandibles black. A brown dorsal patch on first segment of thorax and a pair of brown spots situated dorsally on each of the two following segments. These thoracic segments paler pink than following abdominal ones. Latter nine in number, bright pink to reddish pink in colour except last which is smaller and brown posteriorly where it ends in two small black processes. The larva tapers anteriorly and has three pairs of legs on the thoracic segments and no others. It is slightly lighter in colour beneath.

Beetle.—The shape of the head and prothorax of this beetle are ant-like, whilst the body is short and squarish and not unlike that of a longicorn beetle, having well marked 'shoulders.' Head and antennæ black. The antennæ are 11-jointed, the joints slightly increasing in width upwards, the last three forming a small club, the last joint of which is the largest. Prothorax black with hairs on the dorsal surface. Both head and prothorax are narrower than the elytra which are broad and rounded at their apices; in colour these are red for about the basal quarter of their length, this colour then changing to black; the black is twice crossed by white wavy bands, the first a narrow one just above the juncture of the black with the red colour and the other a broad one about ¾ of the length from the base. Legs black. Tarsus of front legs 4-jointed, of the hind pairs 5-jointed; 1st tarsal joint short. Abdomen on the under-surface is bright vermilion, its segments being very mobile. Body short, somewhat flattened, pubescent. Length varies from $\frac{5}{16}$ths inch to ½ inch. Males may be of same size as the females or the latter may be much larger. Fig. 4 in Pl. X shows the imago of this insect.

Life History.

It is probable that this beetle is to be found on the wing more or less continuously from spring to the end of autumn in the localities which it affects. Its eggs are laid on the bark near or in the entrance holes of bark-beetles, and the young larvæ, on hatching out, find their way through this hole into the beetle gallery and thence into the larval galleries of bark and wood-boring grubs. Larvæ of all sizes are generally to be found in these situations in, as far as my present observations go, every month between May and October. The larvæ, as their description will have shown, are unmistakeable, but I am not at present able to say whether those noticed belong to more than one species of *Clerus* or not. The larvæ here alluded to were found feeding upon the grubs of the two species of *Scolytus* beetles already described, and are especially predaceous upon these, searching them out in their galleries between the wood and bark and devouring them. The length of time spent in the larval stage is unknown. When full fed, they go into the outer bark and pupate there. The beetle, on maturing, never enters the tree. It is a brightly-coloured very active insect running and flying well even in hot sunshine, and it lives outside the tree flying round or running about on the outer bark. Its food consists of bark and wood-boring beetles, and it searches for these on the bark and seizes them whilst they are engaged in either boring into or tunnelling their way out of the tree. In the case of the *Scolytus* beetles, on which it was preying when discovered, it is able apparently to live upon them longer than upon many other species, as these beetles remain alive after their egg-laying is over and the larvæ have hatched out. The mother beetles spend their time walking up and down the egg-gallery or going up the entrance hole to the outside, and the Clerids watch at the mouth of these holes and seize the beetles when they appear outside the bark. They catch their prey by sight only, and not by scent. Unless the bark-beetle is right in front of them, they will pass it by unnoticed. When the beetle, however, comes within their line of sight, they pounce upon it, just as a tiger does when seizing its prey, with one rush. If out of its hole, the bark-borer has not the remotest chance of escape. The Clerid seizes it with his forelegs and mandibles (see Pl. X, fig. 4, b,), picks it up off the ground, turns it round so as to have the ventral surface facing him with the head uppermost. (see Pl. X, fig. 4, c.) sits well back on its hind legs, and commences to feed upon its prey, whose struggles are quite ineffectual in that deadly grip. In commencing upon the beetle the Clerus invariably starts with the head; it gets its mandibles round the junction of the head with the prothorax, *i.e.*, round the neck, following the parallel of the tiger, and chews and sucks at the neck and head until it has finished them completely. It next goes to work on the prothorax, piercing with ease through the hard outer chitinous shell with its powerful mandibles and breaking it to pieces, the contents being entirely cleaned out and consumed, for the beetle is a neat feeder and entirely cleans the meat off the chitinous bone before rejecting it Having finished the prothorax, it throws away the mangled shell and turns its attention to the body consisting of the meso- and meta-thorax and the abdomen. In a bark-beetle this is often in the shape of a blunt elliptical cylinder with a flattish top where it joins the prothorax. The beetle holds this between its front legs flat top upwards and proceeds first to pull off the elytra, which are rejected: the under wings being released open out to their full extent but remain attached to the trunk. The Clerus then entirely cleans out this bottle-shaped cylinder as neatly as one could clean out a jar with a spoon. When entirely empty, it is thrown away and the insect starts in search of another beetle. A mangled prothoracic shell and the empty chitinous body cylinder with the outspread lower wings is all that is left of a *Scolytus major* beetle six minutes from the moment it was captured alive. I have seen three such eaten successively, and of 20 beetles put in with four Clerids only the above-mentioned portions remained when the box was inspected about 3½ hours afterwards. As has been already said, the resemblance between this insect and the tiger in their methods of rushing upon, seizing and starting to feed upon their prey is remarkable, the difference being that the insect is more cruel than the mammal since it makes no pretence of killing the bark-beetle, but commences on it whilst it is alive and kicking, often bringing forward its middle pair of legs to assist in holding its struggling prey.

This insect is polygamous, excessively so, and in the case of some species kept for several days and fed daily with bark beetles of various kinds, I was able to note that whenever the one male, which was kept with three females with this purpose in view, was not actually eating a bark-beetle or searching for one to eat, he was pairing with one or other of the females. I have not as yet been able to ascertain how long these beetles live in this stage of their life history, but it is this excessive polygamy and the larvæ of all sizes to be found in the bark-borer's larval galleries that leads me to consider that the beetle's life is of some duration, or that at any rate beetles will be found from spring to autumn more or less continuously.

To sum up my observations on the habits of the ♂ I may say that, when not eating or searching for bark-beetles, it is pairing and *vice versâ*, and the ♀, at any rate up to the time she commences egg-laying, appears to be an equally large and voracious feeder.

Locality from where reported.

The insect was discovered in the forests near Deota and Pajidhar in Tehri-Garhwal, North-West Himalayas (Jaunsar Division). Elevation between 7,000 to 8,000 feet.

Relations to the Forest.

From the foregoing description of the habits of this beetle it will be seen that it is pre-eminently an insect of the greatest use to the forester. It is a very easy beetle to recognize both in its larval and adult conditions, and it would be advisable, I think, that officials in charge of forests which it affects should endeavour to make themselves acquainted with it. Its discovery is one of some importance. Although perhaps a different species, it will not improbably be found to be closely related to *Clerus formicarius,* which is known to be of the very greatest service in keeping down bark-beetles in European continental forests. So great is the value attached to this beetle that in 1892 a specialist was deputed from America to import it into that country in the hopes of bringing down to normal proportions some devastating bark-boring beetle attacks.

This Clerus was found upon the bark of deodar trees infested with the two *Scolytus* bark-borers, and observations would tend to show that these latter beetles are to be found throughout the months from May to October. The reason is that they do not die off as soon as their egg-laying is finished, and it is possible that the first beetles from the larvæ hatching out from the eggs laid by them commence to issue before the mother beetles have all died off. In this way there would be a continued supply of *Scolytus* beetles for the Clerids.

But though this may be the case, I have ascertained that the Clerus does not confine itself to the *Scolytus.* I have fed it with the following beetles, all of which it eat with avidity:

Platypus or *Diapus* sp., (*Platypodæ*) from deodar wood.

Tomicus sp. the Blue Pine Tomicus.

Polygraphus major and *P. minor* from deodar and Blue pine.

Pityogenes coniferæ from deodar and Blue pine.

It has also been found on the *ban* oak (*Quercus incana*) where it feeds upon the Platypus, *Diapus impressus,* or a closely allied species.

It would thus seem to be fairly omnivorous as far as coniferous bark-beetles are concerned. It will not eat dead beetles.

Protection.

The fact that the larvæ of this beetle pupate in the outer bark and that the beetle never goes into the tree renders its immunity from destruction great. Under the prescriptions for getting rid of bark beetles (see p. 206 *ante*), we have to bark the trees when they are full of grubs and expose the bark to the sun. This kills all the bark beetle larvæ. To a certain extent many Clerid larvæ will also suffer, but the mature ones will at once move into the outer bark and pupate there, and the barking will have no effect upon them. In the case of the beetles, the barking of the trees will have no effect whatsoever since they never go into the tree. We thus see that in the case of this insect remedies undertaken to get rid of its food beetles will not necessarily kill either it or its larvæ, though many of the younger ones may die off with the *Scolytus* larvæ. There will not for some time to come be much fear of the Clerids suffering from want owing to a bark-beetle famine occurring from these operations.

I have also found the Clerid on spruce feeding upon two species of wood-boring beetles, *Ryncholus* sp. and *Hylastes* sp.

Points in the life history requiring further observation.

1. Length of life of the beetle. Does it appear continuously in the beetle state from May to October?
2. Length of time spent in the larval and pupal stages.
3. The number of eggs laid by the ♀ beetle.
4. The number of generations passed through during the year.

BRACON SP.

Classification:—Order, HYMENOPTERA. Family, Braconidæ.

Predaceous upon *Scolytus minor*, MS.

Some nearly mature species of a *Bracon* fly were found in a deodar sapling at the end of the first week in June in the pupating chambers at the end of the larval galleries of the bark-borer *Scolytus minor*. The tree was growing at a low elevation and the eggs were probably laid at the beginning of May. The insects were too immature to identify further with any certainty. These flies are evidently parasitic upon the larvæ of the small Scolytus beetle. The eggs are laid by the female insect, who probably pierces through the bark and deposits them in the larval tunnel or she may place them in the entrance tunnel. The young maggot feeds upon the larvæ and does not kill it until it has reached its full growth and gnawed out its pupal chamber.

I have no further observations on the habits of this insect at present.

SCOLYTUS DEODARA,
MS.

THE DEODAR BRANCH GIRDLER.

Plate X, fig. 5, a, b; Plate XII, figs. 1 and 2.

Reference :—Provisionally named as *Scolytus deodara*, MS.

Classification :—Order, **COLEOPTERA.** Family, **Scolytidæ.** Sub-Family, **Scolytini.**

Tree attacked :—*Cedrus deodara*. The deodar.

Description.

Larva.—When just hatched, the larva is a minute white circular ball.

Beetle.—This *Scolytus* is intermediate in size between *S. major* and *S. minor*, MS. The beetle is black in colour, moderately shining, cylindrical, the elytra being slightly tinged with rufous-brown, as are the legs; antennæ yellowish brown and tarsi yellow. Head projecting beyond prothorax with a broad rostrum. Eyes transverse, almost vertical. Behind the eye the head is thickly striated with close-set vertical striæ which are produced down on to the ventral surface. This is not present in *S. minor*. Antennæ short with a 7-jointed funiculus and a long club. Prothorax not longer than broad, no so thickly punctured as head, and punctures lighter and fewer behind. Elytra fairly thickly striated and punctured and sparsely covered with golden yellow hairs, more especially on their lateral portions, as are the prothorax and head. Abdomen flexed upwards posteriorly. Length 3·2—3·5 millim.

Pl. X, fig. 5, a, shows a dorsal and side view of this insect.

Life History.

This beetle is a branch girdler and makes its first appearance in the year about the third week in June. The period probably varies and is dependant upon the first burst of rain. It lays its eggs in deodar branches either on large trees or on saplings.

The branches are always of a fair thickness, being as much as ¾ inch in diameter at times, there being several forks or side branches above the spot attacked. The beetle bores into the branch to the cambium layer and then mines in this horizontally round the stem until it has completely girdled the branch, the gallery being kept so horizontal that the insect always exactly meets, or very nearly so, its hole of entrance. The groove goes deeply into the sapwood as well. (See Pl. XII, fig. 2, A, 1.) At the upper edge of the gallery small nicks are cut on the shady side of the branch and eggs laid. More than one egg is laid and the number may be as many as eight, perhaps more. Pl. X, fig. 5, b, shows a branch girdled by this insect at (1)· After laying her eggs, the beetle leaves the branch by the hole of entrance which is just above the groove and may possibly attack others in the same way before she dies. This point has not been fully observed as yet. Owing to the deep groove cut by the beetle and the heavy weight of the needle-bearing branch above it, the latter very soon bends over and hangs down (until it does this, there is nothing to show that the branch has been attacked save the small entrance hole from which resin exudes), attached by a few shreds of bark and wood to the branch below the cut and a certain amount of resin exudes round the groove. This pendant position of the fresh green branches renders fresh attacks at once perceivable, and the amount of damage done by these beetles, once their life history is understood, is very easily discoverable. Pl. XII, fig. 1 shows a dead top, girdled the previous year, hanging down in this manner. The young larvæ hatch out, from the eggs laid in the nicks above the girdle, in a few days since quite young larvæ are to be found just boring away from the cut whilst the cut branch is still quite fresh and green. The girdle is of course made by the beetle to prepare a sufficiency of food material in the withering condition required by the larvæ developing from the eggs. The larvæ bore straight up the girdled branch in the cambium and sapwood eating out slightly winding galleries about 1¾ to 2 inches in length which are filled all the way up with wood dust and excrement (see Pl. X, fig. 5, b (2)). When full grown, they eat out in the sapwood a chamber slightly larger than the gallery and pupate in this. The beetle on maturing bores its way out by a horizontal hole through the bark. At present I have never obtained more than one beetle from any one attacked branch, although more than one larva hatches out and bores up the stem (Pl. X, fig. 5, b). The life cycle of the first generation of the year takes from 6 to 7 weeks from egg to beetle. From branches found freshly girdled on July 3rd the writer bred out beetles in the latter part of August. The larval stage of this generation probably lasts about 4 weeks. It is possible that the beetle commences egg-laying so late in the year, *i.e.*, after or at the commencement of the first rains in order that the girdled branch may remain fresh for a sufficiently long time to enable the larvæ to become full grown and change into the pupal state before it withers to any great extent, since it is evident that the grub requires fresh cambium and sapwood for its food. Occasionally the same branch will be found to have been girdled twice probably by different beetles, but this is not common. Pl. XII, fig. 2, A, shows an instance of the branch being girdled at 1 and 2.

I am of opinion that there is likely to be at least one more generation of this insect in the year, the August beetles probably girdling branches and laying eggs in them as soon as they issue. The exact number of generations in the year has however yet to be worked out.

Localities from where reported.

These beetles or the results of their work have been observed to be plentiful in the pure deodar woods in the Jaunsar and portions of the Simla Hill States Divisions in the N. W. Himalayas. Their attacks have been more especially noticeable at Kathian and Deota in the Jaunsar Division and in the Cheog Forest near Simla and in the deodar forest at the head of the Simla waterworks.

Mr. Lace, whilst in charge of the Chamba Division, Punjab, noticed that deodar branches were girdled by an insect, and the beetles he obtained appear to be the same as the one under consideration.

Relations to the Forest.

This scolytid attacks deodar trees of all ages. Large trees may be observed to have a curious irregular shape owing to numbers of the branches having had their ends 'cut' by this beetle. The work of the insect can be always recognized as, if the end of the branch is examined, a portion of the groove made by the beetle will always be observable at its extremity. This curious raggedness in the shape of the tree becomes even more marked in the case of smaller trees, and the number of branches thus treated must seriously interfere with and retard their growth. But the attacks become more serious still when we come to the sapling stage. Here we find that the beetle often attacks and girdles the leading shoot (see Pl. XII, figs. 1 and 2, B, 3) and this with subsequent girdling of other side shoots leads to misshapen trees which can be easily recognized in the plantations. It need hardly be stated that this is the most serious result of the insects' attacks. Fig. 1 in the plate shows a young sapling with its leading shoot cut off by this insect, whilst fig. 2, B, shows the top of another sapling in which two side shoots have taken the place of the girdled leader at 3.

I have noticed that whilst the insect appears to be invariably at work in pure deodar forests, it is much rarer in mixed forests —a point worthy of some consideration.

The insect is exceedingly wasteful in its method of egg-laying. Large branches are girdled, often 2-3 feet in length and with several forks or side branches to them. From the whole of this large cut branch but 1½ to 2 inches are grooved up from the base by the larvæ hatching out from the eggs laid. The rest of the branch thus destroyed is, as far as this scolytid is concerned, entirely wasted.

It will be generally found that the upper part is attacked by a small polygamous scolytid beetle, Hypoborus (?) sp., described at p. 278 of these notes.

Protection and Remedies.

It has been already stated that the branches usually harg over to one side after being girdled, and when this is the case there is no difficulty in observing the beetles' operations

Even if the branch remains still erect, the entrance hole, as evidenced by the exudation of fresh resin on the bark, can be seen.

In small plantations and wherever practicable it is recommended that all such freshly attacked branches should be collected and either burnt or the bark peeled off from the girdle downwards for several inches. This will expose the eggs or young larvæ, and they will be killed off. Branches not actually freshly attacked which may contain pupæ should be burnt. If this is systematically done in a plantation and, owing to the attack being so easily recognizable, the work should not be difficult, it should be possible to keep this pest within bounds and protect many promising young saplings at any rate until their leading shoots get beyond the beetles' attacks.

Collecting all dead branches in the winter months and burning them may also kill off the overwintering beetle, or whatever stage it is in, inside them.

Points in the life history requiring further observation.

1. The number of generations in the year. If there is a second one, the length of time spent in the larval and pupal stages.
2. In which stage of its life history does the beetle pass through the winter? This will not unlikely be the pupal, but may be the beetle stage. Is this stage spent inside the girdled branch which will by then be dead, either fallen to the ground or still attached to the tree? If so, the collection and burning of all dead branches during the cold weather months is strongly to be recommended.
3. How many eggs are laid at the girdle, and how many of them normally develop into larvæ? Of these larvæ how many ordinarily reach the beetle stage? At present observations would seem to show that only a few of the larvæ which hatch out really reach the beetle stage. Further observations are required on this point.
4. Does the beetle attack any other trees besides the deodar?

TOMICUS SP.

THE BLUE PINE TOMICUS.

Plate XIII, fig. 1 a, b, c, d.; Plate XIV; Plate XV, fig. 1.

Reference :—Provisionally determined as *Tomicus sp.* near to *T. typographus.*

Classification :—Order, COLEOPTERA. Family, Scolytidæ. Sub-Family, Tomicini.

Trees attacked :—*Pinus excelsa* (blue pine); *Picea Morinda* (spruce).

Description.

The *larva* is a small, white, curved, legless grub, about 4·5 millim. in length, with a yellow head and greatly developed thoracic segments. See Pl. XIII, fig. 1, *a.*

The *pupa* is white in colour and has the ordinary beetle shape.

The *beetle* is at first light yellow and rests for some time in the pupal chamber, whilst its outer parts are slowly hardening, the colour changing as this process takes place to dark yellow-brown the insect finally becoming dark-brown. When ready to issue from the wood, the beetle is shining, oblong, hairy beneath, with scattered hair on the dorsal surface. The head is hidden beneath the thorax and is scarcely visible from above; the thorax is 2½ millim. long by 1½ millim. broad; its dorsal surface with a fine sparse punctation over the posterior half, whilst covered in front with small tubercular projections; elytra cylindrical, with impressed striæ, the intervals being punctured; the elytra slope down at the apex, the sloping portion being excavate; apical excavation shining and irregularly punctate, with five teeth on either side, the third of which is the largest, the fifth being little more than a raised lump or projection. This beetle would therefore appear to differ from *T. typographus* in this respect as the latter has only four teeth on either side. Under surface of abdomen is flat. Tarsal joints 4 in number and simple. Length of beetle 5·2 to 5·5 millim. (⅕th inch or a little over).

Pl. XIII, fig. 1, *b*, shows the pupa and *c*, the mature beetle.

Life History.

The Blue Pine Tomicus beetles appear on the wing towards the end of April at elevations of about 7,000 feet, the date of first appearance varying with the elevation at which the insect is living, being later at higher elevations. These beetles lay eggs from which the beetles of the first generation of the year mature about the middle of June. At the lower elevations it is probable that a second lot adults make their appearance about the end of August. I have obtained a third brood about the middle of September, whilst in favourable seasons and localities a fourth, or portion of a fourth, generation is completed before the winter sets in and puts an end to its activity.

The beetles are found in April boring into the trunks of blue pine (*Pinus excelsa*) of all ages from the pole stage upwards. When it has reached the bast, the insect gnaws out an irregularly shaped pairing chamber, often as much as ½ × ¼ inch in size. (See Pl. XIV, Pl. XV, fig. 1.) When this is ready, coupling takes place, several female beetles entering by the same tunnel and being fertilized by the male. Usually from 2-5 egg-galleries are excavated, grooving both bark and sapwood, radiating from the pairing chamber (Pl. XIV, e, Pl. XV, fig. 1, e) and more or less in the long axis of the tree. These galleries, which contain generally only one air-hole (Pl. XIV, a) *i.e.*, a hole bored horizontally through the bark to the outside to admit air into the egg-gallery, are from 2½ to 3 inches in length and are bored by the female beetles. On the right and left, but apparently chiefly on the right, the ♀ eats out little recesses, laying in each an egg, from 20 to 30 being generally deposited in each gallery; the galleries are blocked up with wood-dust. As it is probable that only one egg-gallery is bored by each ♀, it would appear that the ♂ beetle pairs with 2-5 females. Pl. XIII, fig. 1, d shows the pairing chamber, *p*, and three partially completed egg-galleries, *e*, with a beetle in the shorter one. In the two longer galleries the notches in which eggs have been placed may be seen on the left edge. The first larvæ make their appearance before the egg-laying is over and at once commence to eat out winding galleries in the bast which have a general direction at right angles to the direction of the mother-gallery. The greater number of the larvæ appear to develop from the eggs laid on the right hand of the gallery (see Pl. XIV, Pl. XV, fig 1, *l*,) as the mother bores away from the pairing chamber, but I have not yet been able to account for this. As the larvæ increase in size so does the diameter of the tunnels they are boring; they go deeper into the bark, and the whole plan of the mother and larval galleries remains indelibly impressed on the bark, long after the beetles have matured and left the tree. The larval borings do not groove the sapwood, consequently this latter only bears the impression of the pairing chamber and the egg-galleries with the notches cut by the beetles for the reception of their eggs. In the case of an old attack, therefore, if one wishes to find out whether the eggs hatched out and the larvæ became full grown, it is necessary to inspect the bark on the inside in addition to the sapwood. The mother-galleries are often as much as three inches in length and those of the larvæ, which are often very winding, 1½ to 2½ inches. Plate XIV shows a piece of blue pine bark, ⅔ths natural size, riddled by this beetle: *p*=pairing chamber; *e*=egg-galleries and *l* the larval galleries. The larvæ pupate at the end of their galleries in the bast during the first days in June. Towards the middle of the month the new beetles, now mature, leave the tree through round holes bored horizontally through the bark from the pupating chamber and immediately attack fresh trees and lay their eggs in them. The larvæ from these eggs soon make their appearance and the resulting beetles issue about the beginning of August. As I have said, a third generation (tihs would probably be only the second at higher elevations) of beetles appears in the middle of September and from eggs laid by these the larvæ of a fourth during October. In favourable years some of these latter develop into beetles which hibernate through the winter either in the pupal-chamber or, not improbably, if fully mature, in the thick bark of the trees. The remainder of the larvæ pass the winter at the end of their galleries, in which they gnaw out a small chamber and then envelope themselves in a thin papery cocoon. Those which, as above described, go on to the beetle stage are the beetles of the fourth generation and are the ones which appear in the spring (April) and lay the eggs of the first generation of the year. The hibernating larvæ change early in the year into pupæ and these into beetles, the latter appearing also about the beginning of May, and this leads to the generations overlapping to some extent.

It is probable that when the circumstances of its environment are unfavourable, such as damp, very cold, weather, shady places at high elevations, etc., the normal number of generations passed through during the year is two. Similarly, in very favourable situations and in warm, dry years it is not improbable that the insect will be found to pass through four life cycles.

Localities from where reported.

This *Tomicus* was first reported from the Chogaun forest, in the Bashahr State forests, Punjab, by Mr. Minniken, the Forest Officer in charge, in August 1900.[1] On May 8th, I found the insect in abundance in some Blue pine trees near Konain in the Jaunsar forests, United Provinces and Oudh, and from this date till the middle of July either the insect itself or evidences of its attack were found in more or less abundance throughout the portions of the Jaunsar, Simla Hill States, and Bashahr Divisions visited, the march taking me (after leaving Jaunsar) *viâ* Morach through the Jubal and Bashahr States to Kotgarh and thence on up through the Sutlej Valley Forests to Kilba and the Rogi Cliffs.

Relations to the Forest.

This insect both in the larval and beetle state does serious injury to the Blue pine and to a lesser degree, as far as present observation has shown, to the spruce (*Picea Morinda*). By the latter statement it is not meant that the actual damage done to the tree itself is less, for the bast of some trees has been found completely riddled by the beetles, but that only trees here and there have been noticed attacked by the insect up to the time of writing, whereas the Blue pine has been found infested in blocks.[1]

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[1] Mr. Minniken reported the attack to Mr. Ribbentrop, at the time Inspector-General of Forests to the Government of India, and the latter went up and studied it during September. It is alluded to in a note published by Mr. Ribbentrop at p. 561 of the *Indian Fsoreter*, Vol. XXVI.

The *Tomicus* is not usually to be found in young poles and I have not noticed it attacking young growth. In older poles it is often present, but it apparently prefers the older trees whose bark is thicker; when attacking poles it confines its operations more especially to the lower three-quarters of the bole, leaving the upper quarter and the branches to its companions, *Polygraphus major*, MS. and *Pityogenes coniferæ*, MS.[2]

The injuries to the tree are confined to the bast layer, and when it is badly infested, this part of the tree is completely riddled and destroyed, resulting in death. Attacked trees can be recognised by the shot-hole borings in the bark, each having a little saw-dust at their entrance which has been ejected by the beetles when making the burrow. If trees with large numbers of these holes on their outer bark be cut into the cambium layer will be found to be swarming with either larvæ, pupæ, or beetles.

The European beetle *Tomicus typographus* is considered to be one of the most destructive of all forest insects in Europe, and when conditions are favourable to it, I am of opinion that its Indian confrère is not one whit the less dangerous. Sickly trees, ringed trees, and newly felled ones are at once attacked by it, and its powers of rapid multiplication, which have been shown to be very great owing to the number of eggs laid by the ♀ beetle and the number of generations it is capable of passing through during the year, enable it to spread rapidly over large areas. When particularly abundant in a locality, I have found it attacking green healthy trees. It does not attack barked trees, and it has not been found in stools or stumps.

Its favorite resorts at present in the areas visited would appear to be the forests where the system of ringing the Blue pine to give more light to and so encourage the young Deodar has been carried out on a large scale. In such areas I have found the beetle in enormous numbers. Spruce treated in this way have also been noticed as badly infested. On an area[1] containing some fine spruce through which a severe fire had passed several years previously I noticed a number of fine, large, dead trees which had been badly scorched by the fire. An examination showed that the *Tomicus* had subsequently come in and attacked the trees in large numbers, killing off those which might otherwise have recovered.

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[1] Since this note went to press investigation of dead and dying trees has shown that the Tomicus is probably nearly, if not quite, as injurious to the spruce.

[2] See pages 234 and 242 of these notes.

Protection and Remedies.

I have already alluded to the system in force for a time in these forests of girdling dominant Blue pine and to a less extent spruce, with a view to giving more light to, and so encouraging the growth of, the young and more valuable deodar beneath them. The large number of girdled and slowly-dying trees thus existing in the forest has undoubtedly favoured the increase of this *Tomicus*, which now exists at various centres in the forests in large, and it would appear, rapidly increasing, numbers. The insect will not attack barked trees or trees whose bark is already dead. A girdled tree dies slowly and its bark remains fresh for some time, perhaps a year or two. If the girdle has not been cut entirely the tree will remain alive for several years. In every case, however, the pine will be in the exact condition preferred by bark-beetles, and, as long as the bark remains fresh enough, the *Tomicus* will attack it. The one girdled tree may thus rear up several generations, from four to a dozen or more, of the pest before the bark is either entirely riddled or has died to such an extent as to be no longer to the taste of the beetles. The same would, I think, apply if the trees were only topped instead of being girdled as they would run the risk of becoming diseased and would then not improbably be at once attacked.

If, on the other hand, the tree is felled outright instead of being ringed or topped, its bark will become dry and distasteful to the *Tomicus* within at the latest six months, and that tree will support at the most but two generations of the beetles and most probably not more than one.

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[1] On the northern slope of Hattua, above the Simla-Thibet Road, a few miles from the Narkanda Bungalow,

In May 1901 I was able to inspect some Blue pine which had been felled outright in June 1900 and left with the bark on. The bark was now quite dry. These trees were not noticed to have been attacked at the time of felling but examination showed that they had been badly infested by the July beetles, and perhaps by the later generations. The greatest number reared, however, was not more than two life cycles.

My recommendations for future treatment, with the object of reducing the numbers of these beetles in the forests and preventing further spread from the infested centres, an occurrence which is undoubtedly taking place, are as follows:—

1. That in future, when it is considered necessary to remove the Blue pine or Spruce from around the Deodar, the former trees should not be girdled but felled outright and at once barked and the inside of the bark exposed to the sun's rays.
2. That all still green girdled standing trees be treated in this way.
3. The trees should be barked during the second or third week in May, the beginning of July, the middle or third week in August, and the beginning of October. The reason for this is that the larvæ will then be still young and may be killed by the drying up of the bark. Since, however, the generations overlap (owing to the first laid eggs developing sooner than those deposited at later dates), there will certainly be either pupæ or beetles which will not be affected, and these will issue in due course.
4. There will be no harm in felling the trees at earlier dates, provided the barking is done at the periods specified.
5. That both girdling and topping trees should be discontinued.
6. At all infested centres I recommend that a system of "trap trees" be prepared. For this purpose sickly trees, suppressed trees, etc.,

should be chosen in suitable localities where they can be easily reached and watched. These trees should be felled, the bark being left on. The beetles will resort to them in large numbers for egg-laying, choosing them in preference to adjacent standing trees. When egg-laying has ceased, these trees should be barked.

As we do not yet know exactly how many generations there are in the year at different elevations, I recommend that the system of "trap trees" be kept up and watched carefully from the middle of April to November.

7. As far as possible, apparently uninfested forests should be inspected for attacks of the pest (I have already discussed how such can be recognized). When badly infested trees are found, they should be treated as above.

If the above methods are put in force, it should be possible to reduce the numbers and spread of the Blue Pine Tomicus and bring them down to the normal condition, in which state it may be left to be dealt with by various predaceous insects which feed upon it, several of which have been discovered and will be described in these notes.[1]

In conclusion, I may mention that in the Chogaun forest in Bashahr, from which the attack was first reported in 1900 by Mr. Minniken, the latter informed me that he cut out in that year many of the badly infested trees and sent them down a rough timber slide to the Sutlej River, down which they were floated to the timber markets. Trees that can be so treated should be first barked or they will be liable to spread the pest, the time spent between felling and reaching the river being in all probability quite sufficient for this purpose. The attack in this area was again very bad in June 1901 and had by no means been stamped out.

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[1] Since this note went to press, several fresh predaceous beetles, especially *Histeridæ* and Ichneumon and Bracon flies, have been discovered attacking this Tomicus or its larvæ. It is hoped to treat of these in a future number of these notes.

Points in the life history requiring further observation.

1. The number of eggs laid by the females of the various generations.
2. The number of days which the different stages take to develop, *i.e.*, the time spent in the egg, larval, pupal, and imago stages of the various generations of the year.
3. The range of the insect in India.
4. Whether the *Tomicus* attacks other trees besides the Blue Pine and Spruce.

The principal Insect Allies of the Blue Pine Tomicus.

POLYGRAPHUS MAJOR, MS.

Plate XIII, fig. 2, a, b, c.

Reference :—This insect is new to the British Museum. It may possibly be identical with the beetle mentioned on pp. 63, 64 of my *Injurious Insects* which was determined as near to *P. pubescens* of Europe.

Classification :—Order, COLEOPTERA. Family, Scolytidæ. Sub-Family, Hylesini.

Trees attacked :—*Cedrus Deodara* (Deodar); *Pinus excelsa* (Blue Pine).

Description.

The *larva* when young is a minute, yellowish-white, curved and legless grub of the ordinary Scolytid type. When full grown, it is white in colour and about 3 millim in length.

The *pupa* is whitish-yellow and of the ordinary beetle type.

The *beetle* on emergence from the pupal state is bright yellowish-brown, the tint darkening as the outer parts harden. When ready to leave the tree, it has a moderately shining black head and thorax and dark chestnut-brown elytra covered with a yellow pubescence. The insect is oblong in shape and hairy above and below. The head is not entirely covered by the thorax and has a short, broad rostrum and clubbed antennæ, the forehead bearing a dense tuft of yellow hair. The antennæ have a short funiculus of 5 joints, together shorter than the long solid club. The thorax is broader posteriorly than anteriorly and a small channel marks its juncture with the elytra; the thorax is punctured all over, the elytra being striate and punctured. Legs black, with yellow hairs on them, tarsal joints filiform, yellow, and four in number, the 3rd joint simple. Insect black and shining on ventral surface; 5 abdominal segments visible. Length 3 to 3·3 millim. Plate XIII, fig. 2, a, shows a dorsal and side view of this beetle.

Life History.

The beetles are to be found towards the end of April boring into the trees for the purpose of egg-laying, both blue pine and spruce being affected. The first brood of beetles from these eggs appears during the latter part of June (probably earlier in favourable situations), the generation taking from six to seven weeks to pass through. The beetles maturing in June at once commence egg-laying and a second brood of adults makes its appearance during September, whilst a third generation or a portion of it is passed through before the winter cold puts an end for the time being to the insect's activity. In favourable situations and years it is not improbable that this number of generations is increased, the spring and summer life cycles being gone through at a quicker rate.

The beetle bores its way in from the outside, and on reaching the bast gnaws out in it and the sapwood a chamber of irregular stellate shape (see Pl. XIII, fig. 2, b, c (p)). From this chamber usually three, occasionally four or five, arms or branches take off (fig. 2, b, c, (e)). These branches are the egg galleries and they are bored deep in bast and sapwood, being usually curved and about an inch in length on large branches. The female beetle, as she bores out her tunnel, gnaws out little indentations at the side, placing an egg in each. These appear to be made more on one side than the other as she bores away from the pairing chamber (see Pl. XIII, fig. 2, b (e)), the notches being closer together on this side whilst only a few scattered ones are on the other. From 8 to 15 eggs appear to be laid in each gallery. The larvæ, on hatching out, feed in the bast at first, but as they get older they go into the sapwood and feed there. They bore winding galleries in a direction approximately at right angles to the egg gallery, their tunnels averaging ½ to ¾ inch in length. When full grown they eat out a small chamber in the wood at the end of the larval gallery before changing to the pupal stage. The pupal stage is passed in this, and the beetle when mature bores its way out by a horizontal gallery direct to the outside. Occasionally the larva feeds almost entirely in the bark, but it will bore into the sapwood to make its pupal chamber. This latter is occasionally merely a saucer-shaped indentation in the wood and not bored right in, but the latter is the most usual. I have never as yet found more than two beetles in any one gallery or set of galleries. When the ♀ has finished egg-laying, she bores a short off-shoot gallery off the egg gallery at the end of which she dies or the egg gallery may be prolonged, the end portion, at the head of which she dies, containing no indentations for eggs. In the smaller branches the beetle bores much deeper and the egg galleries are usually much longer. The insect hibernates through the winter either as a larva or perfect beetle.

Relations to the Forest.

This *Polygraphus*, whilst assisting the Blue Pine Tomicus in its attacks upon the older trees in the forest, goes further and infests young growth which I have not as yet found affected by the larger beetle. It prefers the younger portions of the tree where the bark is soft and still thin. The crowns of older trees and the old side branches, and more especially stems and branches of young saplings, are the places it attacks and breeds and feeds in. This preference for the younger parts of trees leads it to infest young saplings whenever, from any cause, they have become weakened in vitality. Young trees broken by snow were found in the spring to be full of beetles, engaged in egg-laying, the insect having subsequently spread to apparently healthy trees alongside. Attacked stems, etc., are at once recognized by the fact that the entrance holes on the outside are surrounded by a circle of white resin which renders them very conspicuous. The thin bark also turns yellow and crinkles up. On cutting into a stem with this external appearance at one of the holes either beetles, or larvæ, or both, will be found burrowing in the bast and sapwood, the galleries being flooded with turpentine in which the insects wallow about. The branches are often so riddled as to be merely a mass of interlaced galleries, the whole of the bast layer disappearing.

In the case of older trees, whenever the bole is found to contain the blue pine Tomicus, *Polygraphus major* will almost invariably, if not always, be found in the crown and side branches. When found in company with the Tomicus it is generally at the boundary line where the latter's attack ceases and that of the Polygraphus begins. On these thicker portions of the tree the pattern made by the beetle is a very easy one to recognize, see Pl. XIII, fig. c.

This Polygraphus is undoubtedly a serious pest in the forest, and its habit of attacking young growth renders it the more necessary that its life history should be well understood and that a constant watch should be kept on its operations, so that any undue increase on its part may be taken in hand at once.

I found it also infesting the *Pinus Gerardiana*, near Kilba, in the Sutlej Valley, Bashahr State.[1]

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[1] Since this note went to press, I have discovered this Polygraphus seriously infesting young deodar saplings in a plantation at Pajidhar in the Jaunsar Division, North-West Himalayas. There were some blue pine in the plantation, and both were badly attacked by the Polygraphus. A fire had passed through a portion of this plantation in January and the trees, weakened but not killed by it, had been attacked by the beetles in May, eggs being laid in the trees. The larvæ on hatching out had entirely riddled the cambium both in the deodar and blue pine, the attack being more severe in the latter. It appeared probable at first that the deodar might have been infested by the Polygraphus after all the blue pine had been occupied, but examination showed that the deodar saplings had been attacked by the beetle in previous years. In some of these cases the trees had killed the beetles by an outflow of turpentine either in the tunnel when entering the tree or in the just commenced egg gallery. In others the galleries in the sapwood were half-grown over, the green cambium edge on either side being plainly visible. Only one or at most two egg galleries are bored from the pairing chamber in the sapwood of the deodar instead of the three which are usual when the insect attacks the blue pine. The larvæ usually mine in the bast only going into the wood to pupate. When this attack was discovered (June 25), the beetles of the first generation were maturing, some having already issued and commenced laying the eggs of the second generation in the deodar saplings which were still alive. The Polygraphus beetles were mostly in the lower ¾ of the main stem of the saplings and not in the tops, the latter being full of the *Pityogenes coniferæ* beetle.

The fact of galleries being found partially or nearly entirely grown over by the cambium shows—

(1) That the trees must have been attacked by the beetles before the growing season of the preceding year. This is of great importance since it proves that the beetle will attack deodar even when blue pine saplings are available close by.

(2) That the trees must have been in good health afterwards to have enabled the cambium layer to have sufficient vitality to perform this work.

(3) The number of these galleries found was few showing that the beetle had not attacked in sufficient numbers to kill the tree.

The fact that this beetle attacks deodar in addition to blue pine and that it can infest green saplings renders it a very serious pest in the forest.

Points in the life history requiring further observation.

1. The number of egg galleries bored from each pairing chamber and the number of eggs laid in each. Does the number vary in different trees attacked, and is it constant for any one species of tree?
2. Does each ♀ bore only one egg chamber?
3. The exact number of generations in the year. Are there ever four or five?
4. Time passed in the various stages of each generation or life cycle.

POLYGRAPHUS MINOR, MS.

Plate XIII, figs. 1, d, 3. Plate XV, figs. 2, 3, 4.

Reference:—This beetle is new to the British Museum collection. I call it provisionally *Polygraphus minor*, MS.

Classification:—Order, COLEOPTERA. Family, Scolytidæ. Sub-Family, Hylesini.

Trees attacked:—*Pinus excelsa* (Blue pine); *Picea Morinda* (Spruce).

Description.

The *larva* is similar to that of the above-described Polygraphus (*P. major*, MS.) but smaller.

The *beetle* also resembles the latter in shape but is smaller. It is oblong, pubescent, with thorax broader behind than in front and head exposed, the latter when seen from above being striated. Head and thorax black, the latter punctured and covered with scattered short hairs. The division between thorax and elytra is well marked. Elytra black with rows of grey-brown hairs running down them. Antennæ as already described for the other Polygraphus and yellow in colour. Tarsal joints 4 in number and yellow. Ventral surface shining, sparsely covered with yellow hairs, 5 abdominal segments being visible. Length 2·5 to 2·75 millim.

Pl. XIII, fig. 3, shows a dorsal and side view of this insect.

Life History.

This beetle was first discovered at the beginning of May boring into blue pine in company with the *Tomicus sp.* It appeared to be in a younger stage of development than the larger beetle, and it is possible that it seeks out trees already attacked by it. The insect remains in the trees longer than the Tomicus and will attack trees whose bark has lost the freshness the latter requires. The beetles infest the bole of the tree and are only rarely found in the tops and branches in company with the *Polygraphus major*.

It is probable that this insect has three to four generations in the year in favourable seasons, the first flight of beetles, from the eggs laid at the beginning of May or late in April, appearing towards the end of May (I have found pupæ and lightish brown immature beetles in the galleries on the 22nd May). These at once lay eggs and a second generation of beetles appears about the beginning of July. Immature beetles were found on 22nd June at about the same elevation as those found on 22nd May. A third brood of beetles from eggs laid by these latter makes its appearance at the end of September and beginning of October and at once lays eggs. These latter develop into larvæ, a portion of which may reach the beetle stage and hibernate as such through the winter. It would appear, however, that a large number pass the cold weather as larvæ enveloped in a thin, white, papery cocoon at the end of their larval galleries which they slightly enlarge. Early in April these probably turn into pupæ, the resulting beetles emerging from the tree towards the end of the month.

The number of generations and time spent in each require further study and corroboration.

The ♂ bores into the bast through the bark of the tree and excavates in it a pairing chamber, being joined there by the ♀. At present my observations have shown me that there are always two beetles to be found in this chamber whilst it is under construction. After pairing has taken place, the ♀ bores an egg gallery away from the chamber in the bast and lays her eggs in this. In Pl. XIII, fig. 1, d, the small chamber, p^1, containing a beetle is the pairing chamber from which an egg gallery is just being started. The usual number of egg galleries bored away from the pairing chamber appears to be five (see Pl. XV, figs. 2, 3, 4, *p. e.*). It often happens that in leaving the pairing chamber the ♀ bores the egg gallery for some distance in the thick bast layer without breaking through the inner surface. In such cases the number of egg galleries bored away from the pairing chamber appear to be smaller than they really are. The larval galleries are situated entirely in the bast and take off approximately at right angles but curve away later on (see Pl. XV, figs. 2, 3, 4, l.). The sapwood is not touched either by the egg or larval galleries. I have not yet determined how many females pair with the male.

Relations to the Forest.

This Polygraphus confines itself almost entirely to the bast and bark of the tree, making no, or very little, impression on the sapwood. Its galleries run in the bast nearer to the outside of the tree than those of the Tomicus which groove deep into the sapwood. Like the latter, however, it apparently appears to prefer the thick bark and bast layer of the main trunk of the older trees. It is always in greater numbers here, though it is to be found more rarely in the softer portions affected by the larger species of the genus (*P. major*). It has also been found in company with *Hylesinus* (?) sp. Its presence can be detected by the small shot holes appearing on the outside of the bark, these latter being much smaller than those of the Tomicus. It also attacks the spruce in a similar manner to the blue pine[1] in company with the Blue Pine Tomicus.

Points in the life history requiring further observation.

1. The number of ♀'s pairing with ♂, and number of eggs laid.
2. The number of generations and the time passed in the various stages of each.

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[1] Since the above notes were written, I have also found the insect boring into the main trunk of a newly-felled deodar, the bast and sapwood of which had already been riddled by *Scolytus major* and *S. minor* (see pp. 203—212) *ante*. This was at the end of June, the beetles being those of the second generation of the year about to lay the eggs of the third generation. This discovery is interesting and important for the following reasons:—

(1) It shows that *P. minor* as in the case of its confrères, *P. major* and *Pityogenes coniferæ*, attacks deodar in addition to blue pine and spruce.
(2) That in attacking deodar it bores into the main trunk as it does in the case of the other two trees it affects.
(3) That it will attack less fresh deodar than will the Scolytus beetles as is the case when it accompanies the Tomicus in blue pine.

I also found one or two half mature specimens in the deodar saplings at Pajidhar which had been attacked by the *P. major* and *Pityogenes coniferæ*. They were at the base of the saplings attacking the harder thicker bark which had formed on the older trees. I found none, however, in the neighbouring blue pine.

PITYOGENES CONIFERÆ, MS.

Plate XIII, fig. 4, a, b, c, d, f.

Reference :—This beetle has also proved to be unrepresented in the British Museum.

Classification :—Order, COLEOPTERA. Family, Scolytidæ.

Trees attacked :—*Pinus excelsa* (Blue pine); *Cedrus Deodara* (Deodar); *Pinus Gerardiana*, F.

Description.

The *larva* is a minute, curved, white, legless grub. (See Pl. XIII, fig. 4, a.)

The *pupa* is white and has the ordinary beetle form. A ventral view is shown in fig. 4, b.

The *beetle* is small, oblong, shining, with head entirely concealed beneath the thorax, and not visible from above. Thorax black, slightly longer than broad, punctured all over and covered with scattered canary-yellow hairs. Elytra rufous-brown, lightly punctured and with scattered yellow hairs; they are channelled and slope down posteriorly, the truncate end being sculptured and bearing small projections which are much larger in male than in the female (*cf.* fig. 4, c and d.) Antennæ and legs rufous-brown in colour. Ventral surface black, shining, and covered with scattered yellow hairs. Tibiæ are spined, Length 2·35 millim. Pl. XIII, fig. 4, c, shows the ♂ and d, a dorsal and side view of the ♀ of this small beetle.

Life History.

This beetle would appear to have at least three (and more probably four) generations in the year. Mature insects are to be found boring into Blue pine trees towards the end of April in company with the *Polygraphus major* beetle, preferring the softer portions of the old trees, saplings, and young growth. The first brood of beetles of the year from the eggs laid by the April beetles (which are the over-wintering ones) appear in June (probably much earlier in favourable localities), a second generation in August-September, whilst mature beetles, probably of a third (or fourth ?) generation of beetles were taken from trees as late as November 17th. These beetles hibernate in the trees during the winter. The exact number of generations requires further careful observation, as they will almost certainly vary with the elevation, aspect, etc., and I am rather inclined to think that they overlap.

The galleries made by this beetle consist of a central breeding chamber (fig. 4, f (p)) having several arms or egg galleries gnawed out in the bast and sapwood. Occasionally the pairing chamber is entirely in the bast from which several, from four to as many as six, short egg galleries take off, the whole having an irregular stellate appearance. The eggs are laid in small depressions made usually on the outside curve (but they may be on the inner one) of the winding egg gallery (see fig. 4, f (e)). The pairing chamber is as much as 3 millim. across and the egg galleries vary in length up to 13 millim. (*cf.* Pl. XII, fig. 4, f, (p) (e).) As many as four beetles have been found in the pairing chamber, and it is probable that each ♀ beetle bores one of the egg galleries. About 10-12 eggs are laid in each gallery. The larvæ on hatching out bore away from the mother gallery, changing to pupæ at the end of their tunnels. They bore mainly in the bast layer, but often when about to pupate bore down into the sapwood and change to pupæ there (see fig. 4 f (m)).

Relations to the Forest.

This little beetle confines its operations to the smaller branches of the Blue pine[1] where the bark is still quite soft. It infests these places in enormous numbers, working in company with the larger Polygraphus. It is to be found in the side branches and upper portion of the leading shoot of older saplings. In smaller ones it infests every part and it then becomes a serious pest, as it would appear to have the power of increasing in large numbers. In the case of the snow-broken Blue pine saplings alluded to as attacked by the larger Polygraphus (see p. 236 *ante*), this beetle was in countless numbers wallowing in the large amount of turpentine contained in the more succulent portions of the young trees. Its attack can be recognized from the outside by the small pin-holes seen in the bark, each surrounded with a small white ring of resin (see Pl. XIII, fig. 4, f (n)); the bark when very young turns yellow under the attack and shrivels up. The arms of the stellate galleries run longitudinally up and down the stem rather than horizontally, and the appearance of the pairing chamber and egg galleries are not unlike those of its larger companion, with which they are often found mixed up and interlaced. The latter are, however, larger, have longer arms and the egg galleries are fewer in number, and go much deeper into the sapwood, this being more especially noticeable in the case of the smaller branches attacked.

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[1] I have since found it in company with *Polygraphus major* infesting deodar saplings. It was very numerous in the tops of saplings already described as attacked by its larger companion at Pajidhar (see footnote on p. 237). In a few cases it was found in the main stem, low down, and the gallery had then only 4 arms or egg galleries to it, the pairing chamber being made entirely in the bast as also were the larval galleries and pupating chamber, only the egg galleries grooving down into the sapwood. In the tops, however, and leading shoots the attack corresponded in all respects to that in the blue pine. I was unable to count the number of egg galleries bored as the bark and sapwood were riddled by the interlacing galleries. All the stages of larva, pupa and beetle, were found, and also mature beetles just boring into the stems to lay eggs. This would seem to confirm my theory that the generations in one year of the life history of this insect overlap one another since it would seem probable that the larvæ were those of the second generation, the first lot of grubs appearing somewhere about the beginning of May. This would mean that the August-September larvæ are those of the third generation, and the November beetles those probably of a fourth which lay the eggs of the first at the end of April in the following year. The Pityogenes was equally numerous in the neighbouring blue pine saplings. As in the case of the *P. major* the fact that this beetle attacks the deodar in addition to the blue pine greatly adds to the importance of the pest and renders it essential that its life history should be understood.

I have not yet found this insect infesting spruce but it or a very close ally occurs plentifully in the branches of the *Pinus Gerardiana* in which its life history appears to be the same as that already given for the blue pine. It was found in this tree towards the end of June near Kilba, Bashahr State.

Points in the life history requiring further observation.

1. The number of ♀'s pairing with each ♂ and the number of egg-galleries bored by each.
2. The number of generations passed through during the year and the time occupied in the various stages of each.
3. Whether the insect attacks the spruce.

Localities from which the species of Polygraphus and Pityogenes have been reported.

The range of these beetles, as far as has yet been ascertained, is the same as that already given for the Blue Pine Tomicus (*Tomicus sp.*).

Protection and Remedies.

The recommendation already made for the treatment of the *Tomicus* attacks apply equally to those of its three allies. In addition it should be mentioned that when young growth is badly attacked by the larger *Polygraphus* and the *Pityogenes*, the signs of whose attacks, as already explained, are easily discernible, it will be advisable to cut out all badly infected plants and saplings and burn them. This should, of course, be done at a time when they are full of larvæ or pupæ and *before* the beetles begin to mature and issue.

CERAMBYX SP.

Order, COLEOPTERA. Family, Cerambycidæ.

Trees attacked :—*Pinus excelsa* (Blue pine) ; *Picea Morinda* (Spruce).

Following close upon the Tomicus attacks and appearing sometimes with them, when these latter insects have weakened the tree by their onslaughts, numerous Cerambyx larvæ are to be found at work, making broad, shallow galleries in the bast and outer sapwood. These larvæ are white in colour, resembling those already described on page 50 in No.1 of these notes (see Pl. IV, fig. 3, a) and were from 1 inch to 1½ inch in length at the time they were found. No perfect beetles have yet been obtained. These longicorn larvæ are dangerous in the forest since their attacks further weaken the trees and minimise or entirely put an end to any chance they might have had of recovering from the bark beetle infestation. Further information is required on the following points :—

(1) As to how long the insect spends in the larval and pupal stages.

(2) At what time the mature beetle appears.

HYPOPHLŒUS FLAVIPENNIS, MOTS.

Plate XIII, fig. 5.

Classification :—Order, COLEOPTERA. Family, Tenebrionidæ.

Description.

The *beetle* is small with a large exposed head, brown in colour, as is also the prothorax which is narrower in front than behind and longer than broad. Elytra yellowish, oval, finely but broadly striate with scattered punctures; they leave one segment of the body exposed. Antennæ are shorter than prothorax, 11-jointed. Legs short. Last joint of tarsus longer than rest together. Length $\frac{5}{32}$nds inch. Pl. XIII, fig. 5, shows a dorsal and side view of this insect.

Life History, etc.

I am at present unable to say what part is played in the tree by this beetle, which is a small heteromerous one. I am not aware that it has ever been reported as injurious. It may possibly be a sap-feeder, but further observation on its habits is required, as also on those of its larva.

The beetle was sent in company with the Tomicus from the Chogaun forest in Bashahr in 1900, it having been taken from the galleries of that beetle (or perhaps from those of its companion Polygraphus ?). The following year, at the end of June, I found it in the same neighbourhood but at a lower elevation in bark-beetle galleries in the *Pinus Gerardiana*, the beetles from whose galleries I obtained immature specimens of it being species of *Polygraphus* and *Pityogenes*.

This is at present all the information I have on the subject.

Some Insect Enemies of Tomicus sp. and Its Allies.

NIPONIUS CANALICOLLIS,

LEWIS.

Plate XIII, fig. 6.

Reference :—Ann. Mag. Nat. Hist. Ser. 7, Vol. viii, November 1901.

Classification :—Order, COLEOPTERA. Family, Histeridæ.

Predaceous upon *Tomicus* sp. (Blue Pine Tomicus) ; *Polygraphus major*, MS., and *P. minor*, MS.

Description.

The larva of this insect has not yet been discovered.

The beetle is cylindrical, oblong, black and shining, the tarsi being palish ; head somewhat robust and sulcate between the cephalic projections ; antennæ elbowed, ending in a club at their tips ; the thorax has a very conspicuous median channel which sometimes reaches the base, but is always somewhat shortened in front ; on either side of the channel the surface is uneven and the punctures irregular in size and form. The elytra have few striæ and leave two segments of the body exposed below their tips. The tibiæ are rather slender, they and the thighs being black.

Length 3½ to 4½ millim. Pl. XIII, fig. 6, shows a dorsal and side view of this beetle.

Life History.

Neither the larval nor pupal stages have yet been observed.

The beetle was first discovered early in May (1901) in the tunnels of bark-borers in the blue pine. Subsequently mature insects were also found in the blue pine trees towards the end of June, these possibly being those of a later generation. The number of generations the beetle passes through during the year is, however, as yet undetermined. Fully mature beetles were found in the trees in the middle of December, amongst imagoes of the Blue Pine Tomicus and the two species of Polygraphus beetles described above. It may be that the number of its generations corresponds to those of its hosts.

Relations to the Forest.

This beetle is a predaceous one and is therefore most useful in the forest since it feeds upon the blue pine bark-borers. It is more especially abundant in the tunnels of the two Polygraphus beetles, and it is constantly present here when no Tomicus beetles are to be found. It is probable, however, that on occasions, at any rate, it also attacks and feeds upon this latter insect, as when some living species of the Tomicus, Polygraphus and the Niponius were sent to me, many of the Tomicus beetles arrived in a half-eaten state. I have not found it attacking the Pityogenes beetle, and the tunnels of this latter are too small for it to enter.

This predaceous insect is found all through the area I have given as occupied by the Tomicus and Polygraphus pests. It has yet to be ascertained whether the adult also feeds upon the eggs, larvæ or pupæ of its hosts, or whether these stages are preyed upon by its own larval stages.

It has also to be ascertained whether it follows the bark borers into the tree, or whether all the stages in its life history are spent there.[1]

CUCUJUS (?) SP.

Plate XIII, fig. 7.

Reference :—Provisionally named Cucujus (?) sp.

Classification :—Order, COLEOPTERA. Family, Cucujidæ

Predaceous upon *Tomicus* sp. (?), *Polygraphus major* and *P. minor*; *Pityogenes coniferæ*; *Scolytus major* and *S. minor.*

Description.

The larva has not yet been observed.

The beetle is oblong, shining, somewhat flat, the elytra being broader than the thorax at their point of juncture with it. Head black and exposed, and punctured, not being

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[1] Since this note went to press, I have found pupæ and mature insects of what I think is this *Niponius* in *Polygraphus major* galleries in deodar saplings (see foot-note on p. 237). The beetles were, I think, feeding upon the nearly mature Polygraphus insects. This would seem to prove that the larvæ feed inside the tree in the larval galleries of the host.

covered by the thorax. Antennæ moniliform, placed in front of eyes, yellow in colour, as also are the legs. Thorax black, rounded in front, squarish behind, very convex and uniformly punctured all over. Elytra rufous brown and punctured, rounded at their tips and leave one black segment of the body exposed. Under-surface black, shining, pitted; 5 visible ventral segments of the abdomen. Tarsi 5-jointed. Length 3·5 millim. Pl. XIII, fig. 7, shows this beetle.

Life History.

This beetle is usually to be found in company with *Niponius canalicollis* in the galleries of the above described bark beetles attacking the blue pine and spruce. Mature beetles were first discovered towards the beginning of May and again towards the end of June. Later on perfect insects of this species were again found in the tunnels of the two species of Polygraphus beetles about the 3rd week in September, whilst in December (on the 15th of the month) numbers of them were taken from trees together with the *Tomicus*, *Polygraphus*, and *Niponius canalicollis* beetles and sent to me.[1]

It would appear that this beetle passes the winter in the imago stage, or that, at any rate, a portion of the last generation of the year does so.[2]

Relations to the Forest.

This insect is as useful in the forest as its companion *N. canalicollis*. It more especially, if not entirely,[2] confines itself to preying upon the two species of Polygraphus, which attack and infest the blue pine and spruce.

I am unable to say at present whether it attacks any of the stages of the Tomicus or Pityogenes insects, but I have never found it in the latter's galleries, and the smaller Polygraphus is almost invariably, as far as my observations go, present with the Tomicus. I have found it swarming in numbers in trees deserted by the Tomicus but still containing numbers of the smaller Polygraphus beetle. It appears to be more abundant, or, at any rate, more "en evidence" than the *N. canalicollis*, and at times it swarms in the galleries in enormous numbers.

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[1] These and previous consignments from September onwards were, at my request, very kindly obtained and sent to me by Mr. J. C. Tulloch, Deputy Conservator of Forests in charge of the Jaunsar Division.

[2] Subsequent observations made since this note went to press have shown me that this beetle is exceedingly plentiful in the Jaunsar coniferous forests. In the galleries of the blue pine Tomicus, the Polygraphus and Pityogenes beetles and even in the galleries of the *Scolytus major* and *S. minor* beetles in Deodar this beetle swarmed between May and July 1902 and through the later months also. It was always to be found in the imago form. Its larval stage has not yet been discovered.

This beetle occurs all through the area over which the two Polygraphus beetles have been found.

The number of generations in the year, the date of appearance of the larval and pupal stages, where they are passed, and the food fed upon in the larval stage have yet to be observed.

POLYGRAPHUS MINIMUS, MS.

Plate XVI, fig. 1.

Reference:—Provisionally named *Polygraphus minimus*, MS.

Classification:—Order, COLEOPTERA. Family, Scolytidæ. Sub-Family, Hylesini.

Tree attacked:—*Pinus excelsa* (The Blue Pine).

Description.

The *larva* is a minute white curved grub.

The *beetle* is very small, black, moderately shining, with elytra covered with scattered longish white hairs. Head small, vertical in front, with a very short rostrum. Antennæ short; scape thick, straight; funiculus 5-jointed; club compact, flattened, ovate; eyes oval. Prothorax cylindrical, narrower in front than behind, and uniformly pitted. Elytra fairly long, rounded at the posterior declivity, not wider than prothorax behind, pitted. Thighs of legs long-oval. Tibiæ finely toothed on their external edge; tarsus filiform, the first three joints of equal size, the third not bilobed. The three intermediate segments of the abdomen of same size and short. Antennæ and legs yellowish-brown. Length 1·1 millim. Pl. XVI, fig. 1, shows this insect.

Life History.

This is the third and smallest of the *Polygraphus* beetles found in the Blue Pine. Present observations would seem to show that it is unlikely to do much damage to the tree. It was found in the third week in May making minute galleries in the bark of the bole of both dying and newly-dead trees. The inner bark where it adjoins the sapwood is the part attacked. It is thus a companion to the Blue Pine Tomicus and the smaller Polygraphus (*minor*). I have found it in a newly-felled tree in company with both. It remains, however, after the Tomicus attack is over, and thus appears to be able to lay its eggs in bark which is not absolutely fresh. The beetle was egg-laying when first found, some of the minute larvæ having already developed from the eggs. I am unable to say whether these larvæ were the first or second generation of the year.

A small chamber is grooved in the inner bark, and in this the male pairs with several females. These latter then bore their egg-galleries away from the central chamber. The larvæ on hatching mine away at various angles from the egg-galleries of the mother beetles. The ♂ would appear to pair with from 4—6 ♀ beetles. The beetles appear to require moist bark to bore in, as they are only to be found either in bark still alive, though nearly dead, or in moist places in newly dead bark. I have never found them in dry bark.

In the third week in June another generation (second or third?) is commenced, as beetles were found, matured from the eggs and larvæ discovered in the third week in May, laying eggs in a similar manner to the May beetles. No larvæ had developed. A spring generation would thus appear to take from four to five weeks from egg to fully developed beetle.

This is as far as I have carried the life history.

Locality from where reported.

This minute Scolytid is plentiful in the Jaunsar and Tehri-Garhwal blue pine forests in the North-West Himalayas. It was discovered in 1902.

Relations to the Forest.

As far as present observation goes, this Polygraphus would appear to do little damage to the tree, since it has only been found in the bole of trees from the pole stage upwards. It comes in after the Blue Pine Tomicus; and probably waits until that insect has undermined the vitality of the infested tree. It remains in the tree, however, longer and will undoubtedly attack bark that is no longer fresh.

Protection and Remedies.

These will be the same as already given for the Blue Pine Tomicus and the other Polygraphus beetles. In getting rid of them this beetle will be likewise killed off.

Points in the life history requiring further observation.

1. The number of generations in the year.
2. Where does the insect lay the eggs of the first generation of the year?
3. In which stage does it pass through the winter in?

POLYGRAPHUS LONGIFOLIA,
MS.
THE LONG-NEEDLED PINE POLYGRAPHUS.

Plate XVI, fig. 2, a, b.

Reference:—Provisionally determined *Polygraphus longifolia*, MS. new to the British Museum.

Classification: – Order, COLEOPTERA. Family, Scolytidæ. Sub-Family, Hylesini.

Tree attacked :—*Pinus longifolia.*

Description.

Beetle.—A small insect with black shining head and prothorax and brown elytra, the latter covered with a whitish-yellow, fairly close, pubescence with scattered longer yellow hairs near the apices of the elytra. This beetle has the same Polygraphus characters already described for the other species of the genus. There is a brush of yellow hairs on the forehead, and the head and prothorax are pitted with not very close-set punctures. The elytra distinguish this beetle from *P. minor*, M.S. which it somewhat resembles in size and build. The antennæ are brown with a yellow club. Legs brown ; tarsi yellow.

Length about $\frac{1}{12}$th inch. Pl. XVI, fig. 2, a, shows this beetle.

Life History.

This insect probably makes its first appearance in the year some time towards the end of April or beginning of May, since mature and nearly mature beetles of what was evidently the first generation of the year were discovered in a young sapling in the middle of June, whilst the insect was found egg-laying at the beginning of July, the eggs being those of the second generation of the year.

The beetle attacks sickly and dying saplings and branches, laying the eggs in the bast layer. It is often found in company with the small *Cryphalus longifolia* beetle.

The *Polygraphus* bores straight through the bark, often ¾ inch thick, down to the bast layer, its hole of entrance being easily visible from outside, as it does not attempt to hide it by tunnelling in beneath a flake of bark or in the shelter of a crevice. On reaching the bast, the beetle bores out a heart-shaped chamber in it and the sapwood. (See Pl. XVI, fig. 2, b(*p*)). This may be the pairing chamber, but as yet I have never found more than one beetle present either in the chamber or egg-gallery. From the base of the heart a longish egg-gallery is bored about 4½ to 5 inches in length, and on each side, at some distance apart, little cavities are gnawed out and an egg laid in each, see Pl. XVI, fig. 2, b(*e*). The larva on hatching out of the egg bores away from the egg-gallery mostly in the sapwood and in a direction which is more or less at right angles to it (fig. 2 b(*l*)). The shape of this gallery is very constant and easily recognizable. The length, however, varies. The sapwood of dead saplings and branches is often completely covered with the patterns of this and *Cryphalus longifolia* described later on in this number of the notes.

I have not as yet ascertained when the beetles of the second generation mature and issue, nor whether, which is most probable, there is a third generation in the year.

Localities from where reported.

The writer first discovered this beetle in the *Pinus longifolia* forests round Taklesh in the Bashahr State, North-West Himalayas. The next year (1902) it was found in Tehri-Garhwal (Jaunsar Division), North-West Himalayas.

Relations to the Forest.

Present observations show that this insect attacks saplings and the branches of large trees. It requires fresh cambium to lay its eggs in and will not touch dead bark. *Pinus longifolia* has a very thick bark which even young saplings develop at an early age. This bark, however, appears to be no deterrent to the beetle, which will often bore into the tree through the thickest ridge of bark on it. The beetle is one which is capable of doing damage in young plantations and to natural regeneration, should the trees of such become reduced in vitality through any cause. In Tehri-Garhwal in the Jaunsar Division, on an area of young growth under high forest swept over by fire in January 1902, I found some of the saplings attacked by the first generation of the beetle and in such cases the young trees had died, whereas the greater number, owing to the strong vitality of the pine and a favouring aspect, had recovered and were quite green at the top though scorched by the fire below.

Protection and Remedies.

Cut out all infected saplings and burn them if they cannot be barked. If barked, expose the inner surface of the bark to the sun's rays. This will be sufficient to kill the larvæ and pupæ present. In the case of serious attacks in the branches of older trees the latter should be felled and treated in the same way since they form centres from which the beetle will spread to young saplings. It will also not unlikely be found probable that old trees, whose branches are badly attacked by this *Polygraphus*, will have their main bole attacked by the large Tomicus (see page 282) of this pine.

From the evidences to be found in young dead trees, and more especially branch wood, in the *P. longifolia* forests, there can be little doubt that this beetle at times swarms in large numbers, and its life history consequently requires to be fully worked out.

Points in the life history requiring further observation.

1. When the insect first commences work in the spring. As the *P. longifolia* lives at low elevations, this is not unlikely to be early.
2. Length of time spent in the various stages of egg, larva, pupa, and beetle of the first generation.
3. The length of time spent in the various stages of the second generation.
4. Is there a third (and fourth ?) generation ? If so, the dates of appearance of egg, larva, pupa and beetle.
5. In which stage of its metamorphosis does the beetle pass through the winter ?

HYLESINUS (?) SP.

THE BLACK HYLESINUS.

Plate XVI, fig. 3 a, b.

Reference :—Provisionally named as *Hylesinus* (?) *sp.*

Classification :—Order, **COLEOPTERA.** Family, **Scolytidæ.** Sub-Family, Hylesini.

Tree attacked :—*Pinus excelsa* (Blue Pine).

Description.

Beetle.—Cylindrical, black, shining, with head and thorax pitted and elytra striated and pitted. Head short, vertical, with a very short rostrum as wide as head. Antennæ brown, scape thickens anteriorly into a knob; funiculus of 7 joints, 1 and 2 long, the first longest and thickest, 3 to 7 short and increasing in width upwards: club nearly as long as funiculus, articulated, oblong, and yellow at upper end. Prothorax slightly convex, narrower in front than behind, thickly pitted, the pits being close together and smaller in front. Elytra longish, cylindrical, rounded at their posterior declivity, not, or only a very little, wider than the prothorax and truncate at their base. Legs fairly stout, with largish tibiæ, curved, and toothed on their exterior edges. Tarsus yellowish-brown, with the first joint a little longer than the second, third a little larger, and bilobed. The second abdominal segment nearly as long as the third and fourth united. Length ⅛th inch. Pl. XVI, fig. 3, a, shows a dorsal and side view of this insect.

Life History.

This beetle was discovered in the blue pine. It bores into the bole of large trees, coming in much later than the Blue Pine Tomicus. The beetles were found boring egg-galleries (?) in the bark in the third week of June when the adults of the first generation of the Blue Pine Tomicus, which were plentiful in the tree, were nearly mature, some having already left the bark. It is thus evident that it requires less fresh bark than its companion, but I have no evidence that it will breed in dead bark. In thus attacking the main trunk it differs from

Polygraphus major, MS., which it resembles in size though not in colour or habits. The beetle is polygamous and as many as eight egg-galleries (?), (*e*), give off from the central pairing chamber, (p), (see Pl. XVI, fig.3, *b*(p), (*l*)) though there may be only 5. I am not, however, able to say whether each is made by a separate ♀ although several of the galleries were found to contain each a beetle. Although the beetles appeared to be boring the egg-galleries, I have not as yet seen any eggs or larvæ, and do not know how or where the latter feed. When the beetle first appears and the number of generations in the year is unknown. The insects found would not unlikely be those of the first generation of the year engaged in laying the eggs of the second generation. The difference in the life history between this and the larger Polygraphus may be summed up as follows :—

P. major was at the time only just maturing as a beetle (first generation) in the branches of the Blue Pine. It was numerous in the tree from which *Hylesinus* sp. was obtained.

P. major does not attack the main trunk of the tree. The tunnels (egg-galleries) of *Hylesinus* sp. differ entirely from those of the large Polygraphus.

Locality from where reported.

This beetle was found in Tehri-Garhwal (Jaunsar Division) in the North-West Himalayas in 1902.

Relations to the Forest.

Until more is known about the life history of this Hylesinus it is impossible to say what damage it does to the trees it infests. The chief point to be ascertained is, whether fresh bark is a necessity to the insect for egg-laying or not. When eggs or young larvæ have been discovered we shall be in a position to form a conclusion on the subject.

Points in the life history requiring further observation.

1. How the beetle lays its eggs, the number laid, and the time passed in the egg stage.
2. Length of time passed in the larval state and the food of the larvæ.

3. Period passed in the pupal state and method of pupation of larvæ whether in the bark or the wood of the tree.
4. Length of time passed in the imago form.
5. The number of generations in the year. If more than one, the information under 2, 3 and 4 and latter part of 1 will be required for each generation.
6. Where the beetle passes the winter.

CRYPHALUS BOSWELLIÆ, MS.

THE BOSWELLIA CRYPHALUS.

Plate XVI, fig. 4, a, b, c.

Reference :—Provisionally named as *Cryphalus boswelliæ*, MS. new to the British Museum.

Classification :—Order, COLEOPTERA. Family, Scolytidæ. Sub-Family, Tomicini.

Tree attacked :—*Boswellia serrata.*

Description.

Larva.—A small white curved legless grub (see Pl. XVI, fig. 4, a).

Pupa.—White, unenclosed in any cocoon or covering, the antennæ, wings, and legs being quite free and held close to the sides of the beetle (see Pl. XVI, fig. 4, b).

Beetle.—Colour black. Head and thorax pitted. Elytra with striæ and wide rows of bluish white punctures between them. Mandibles short. A brush of yellow hairs round the mouth. Scape of the antennæ, which are dark brown, long club-shaped; funiculus four-jointed, the first joint thick, elongated, the 2nd to 4th only slightly increasing in size; club flattened, oval. Eyes long, narrow, transverse. Prothorax not wider than broad, narrower in front than behind, with only pits and not tubercular projections anteriorly. Elytra cylindrical, rounded on their posterior declivity, not wider or only very slightly so than prothorax, slightly bending inwards at their base. Legs dark-brown. Tibiæ curved and finely toothed on their exterior edges; tarsus yellow, with the first three joints of equal length. A very short yellowish pubescence over the prothorax and elytra in this beetle. Length just over $\frac{1}{16}$th inch.

Pl. XVI, fig. 4, c, shows a dorsal and side view of this insect.

Life History.

The flight time of this beetle is about the beginning of August and probably for some time later. The insect in all stages of its life is to be found at the beginning of the month. In branches of the *Boswellia* which appeared to be dying but were still green larvæ were plentiful and also pupæ and light-coloured beetles, the latter not quite mature. The larvæ are to be found in irregular-shaped cavities in the bast and sapwood which usually contain a certain amount of moist wood-dust. In the pupal and beetle stages this latter becomes dry. In other branches darker coloured beetles were present, and these were apparently the mature beetles of this generation which had already begun egg-laying. The ♂ and ♀ beetles were found together gnawing out irregular-shaped chambers beneath the bark in the bast and sapwood. These beetles had apparently only just matured and had at once commenced egg-laying, the eggs being those of a second or third (?) generation.

This is all that has been at present observed about this insect.

Locality from where reported.

This beetle was found in the Bhamburda reserve near Poona in the Bombay Presidency.

Relations to the Forest.

The smaller green branches of *Boswellia serrata* are bored into by the insect for the purpose of laying its eggs in them. The larvæ on hatching out feed upon the surrounding cambium layer and destroy it. If at all plentiful, the bark is eaten right round and the twig, being girdled, dies.

Further observation is required to ascertain whether the insect is at all numerous and whether it infests young plants. In this latter case it might on occasions become a serious pest.

Points in the life history requiring further observation.

1 The number of generations passed through by the insect in the year. This is important. If more than one, we require to know the length of time spent in the various stages of the metamorphosis in each generation.
2. Does the insect attack young plants?
3. Where does it pass the cold-weather months?

CRYPHALUS TECTONÆ, MS.

THE TEAK CRYPHALUS.

Plate XVI, fig. 5.

Reference:—Provisionally determined as *Cryphalus tectonæ*, MS. new to the British Museum.

Classification:—Order, COLEOPTERA. Family, Scolytidæ. Sub-Family, Tomicini.

Tree attacked :—*Tectona grandis*, *L.* (Teak.)

Description.

Larva.—The grub of this beetle is very small, white, curved, and has no legs.

Beetle.—Smaller than *Cryphalus boswelliæ*, MS. Cylindrical. Head, prothorax, and elytra a reddish brown in colour and covered with rather scattered short yellow hairs which are set in rows on the elytra. The prothorax set with tubercular projections anteriorly and lightly pitted posteriorly. Elytra fairly finely striated and fitted with parallel rows of short yellow hairs running down them. Antennæ and legs bright yellowish brown. Under-surface set with longish tufts of white hairs placed irregularly. Length 1·2 millim.

Pl. XVI, fig. 5, shows the imago of this beetle.

Life History.

This minute beetle was discovered boring into the smaller branches of the Teak tree in Berar. The flight time of the insect is about the latter half of July in this part of India. The beetle would appear to have the same habits as other minute *Cryphali* in the continent. It bores into a branch until it reaches the cambium layer and then mines out in this and the sapwood a small chamber, being then joined by a companion. They then together eat out the egg gallery which is simply an irregularly-shaped small chamber made in the bast and sapwood in which the eggs are laid amongst a small mass of wood-dust.

In one case I found a larva, and it would seem therefore probable that the beetles commence egg-laying about the beginning of July in Berar, and that very few days are passed in the egg stage, the larvæ hatching out within a very short time.

This is at present all that has been observed on the habits of this minute beetle.

Locality from where reported.

This insect was discovered in the Melghat Teak forests in Berar.

Relations to the Forest.

Very little is known about this Cryphalus. I am unable to say whether it is at all abundant or otherwise in the Teak forests of the country. It has at present only been found on old trees.

Owing to its method of attack under which the cambium of the young shoot is destroyed by it and its larvæ, it is obvious that if it attacks young growth and were to infest it in any numbers it would be capable of doing serious injury. It will perhaps be found most abundant in localities where the Teak is of inferior growth.

Points in the life history requiring further observation.

1. The number of generations in the year and the length of time passed in the different stages of the metamorphosis of each.
2. The number of eggs laid by the beetle.
3. In which stage the cold weather is passed through.

CRYPHALUS MORINDA, MS.

THE SPRUCE CRYPHALUS.

Plate XVI, fig. 6.

Reference:—Provisionally named as *Cryphalus morinda*, MS. new to the British Museum.

Classification:—Order, COLEOPTERA. Family, Scolytidæ. Sub-Family, Tomicini.

Tree attacked:—*Picea Morinda* (Spruce).

Description.

Beetle.—About the same size as *Cryphalus boswelliæ*. Really black in colour but so thickly set with a dense close golden pubescence as to have that colour. The upper three quarters of the prothorax slopes rather abruptly in front and is thickly studded here with prominent tubercular spikes. Posterior quarter is finely pitted. Elytra finely pitted. Antennæ and legs yellow-brown. Underside of insect black, set with long white hairs. The ordinary characteristics of a *Cryphalus* as given under *C. boswelliæ* are present. Length $\frac{1}{18}$th inch. Plate XVI, fig. 6, shows this insect.

Life History.

The flight time of this beetle is from about the middle to the third week in June. The tree attacked is the spruce, the insect boring into the twigs. The needles on the branches attacked were noticed to be quite dry, but the bark itself was still green, though dying. The beetle commences work by boring in through the bark till it reaches the cambium layer. In this it then bores a small chamber which also goes slightly into the sapwood. Whilst this is being prepared, another beetle joins the first, and in the narrow small elliptical chamber two beetles will generally be found at work as soon as the boring is sufficiently large to hold both. In this elliptical chamber the eggs are laid. This is at present all that is known about the life history of this minute insect. It is of importance to note that at present never more than one pair of beetles have been found together in any one gallery, and it is therefore, I think, not improbable that the male pairs with but one female and is not polygamous.

Locality from where reported.

This insect was found by the writer in the Spruce forest between Goara and Sarahan (Simla-Thibet Road) in the Bashahr State.

Relations to the Forest.

Very little is known about these small insects in India, and it is at present impossible to state what relation they really bear to the forests. I cannot at present say whether this beetle is abundant or not, nor whether it attacks young growth as well as old trees. It has only been found in the latter up to date. It is probable that it usually searches for branches which are weak in health, but examination of dead branches shows that those which it attacks in any numbers it invariably kills. The cambium is entirely eaten away and it is not unlikely that the larva is responsible for a good deal of the damage done. A certain thinning out of the smaller branches must take place on the tree under the attacks of this insect.

Points in the life history requiring further observation.

1. How the larva feeds! Does it simply enlarge the elliptical chamber bored by the parents, or does it bore a gallery off this?
2. The number of generations in the year. If only one, the length of time spent feeding by the larvæ hatching out from the eggs laid by the June beetle and the time passed in the pupal stage.

   If more than one generation, their number, and the length of time spent by the different stages of the metamorphosis in each.
3. The number of eggs laid by each beetle.
4. In which stage is the winter passed through?

CRYPHALUS LONGIFOLIA, MS.

THE LONG-NEEDLED PINE SMALL CRYPHALUS.

Plate XVI, Fig. 7, a, b, c.

Reference :—Provisionally named as *Cryphalus longifolia*, MS. new to the British Museum.

Classification :—Order, COLEOPTERA. Family, Scolytidæ. Sub-Family, Tomicini.

Tree attacked :—*Pinus longifolia.*

Description.

Beetle.—A minute insect, yellow to dark-brown in colour and clothed with a fairly dense mass of long whitish or whitish-yellow hairs. Antennæ and legs bright yellow. Head hidden by the thorax. Mandibles short. Scape of antennæ thickened anteriorly, funiculus of four joints, the first large, longish; club flattened and oval. Prothorax wider than long, convex dorsally, armed with small spiny tubercles anteriorly. Elytra cylindrical, rounded at their posterior declivities, not wider than the thorax. Tibiæ finely toothed on their outside edges. Tarsus with joints 1 to 3 of equal length. Body cylindrical. Length 1 millim. or a little over. Pl. XVI, fig. 7, a, shows a dorsal and side view of this insect.

Life History.

This small beetle was found boring into the branches of old trees and also in the tops and branches of saplings in the first week in June. The insect was engaged in laying its eggs, and these were not unlikely those of the second generation of the year, since the elevation at which it lives is a low one. It infests green sickly branches and also those which are half dry.

In boring into a branch this Cryphalus never goes in direct from the outside, but always searches out some small flake of bark beneath which to bore its entrance hole. The bark of the *Pinus longifolia* is rough even on small twigs, and so it has no difficulty in making its entrance into the branch unobserved. On reaching the bast layer a small irregular-shaped chamber is bored by the beetles, indenting both sapwood and bast (see Pl. XVI, fig. 7, b, c (p)). I have always found two beetles at work making this excavation, and never more than two, the male helping the female. I am unable to say whether pairing takes place before or after this chamber is complete, but as soon as there is room in it for the two beetles, two will be found together. Round the sides of the chamber little indentations are cut (fig. 7, b (e)). By the time the shallow excavation is complete it has become full of white powdery wood-dust and the eggs are laid either loosely in this or in the indentations. At this period only one beetle is present in the egg-chamber. Galleries were found in this condition at the beginning of July. Further than this I have not as yet been able to carry the life history, but from an examination of old twigs and branches it appears that the larvæ mine out winding galleries in the bast and sapwood as shown in fig. 7, c (*l*).

There is at least a third and possibly a fourth generation of the beetle in the year. From some branches taken to Dehra the writer bred out beetles in the middle of September and others may have issued in August since dead beetles were found in the breeding box which, owing to absence on tour, was not opened in that month.

Locality from where reported.

The beetle was first discovered in company with the long-needled pine Polygraphus at Taklesh in the Bashahr State, being obtained the following year numerously in the Jaunsar Division, both situated in the North-West Himalayas. Elevations between 2,000 and 3,000 ft.

Relations to the Forest.

This beetle, though very minute, has the power of increasing in large numbers and must therefore be included amongst the pests of the pine. The tops of saplings and branches are the parts of the tree it infests, the cambium layer being entirely riddled by the borings of the beetles themselves and the subsequent minings of the larvæ which practically girdle the top or twig attacked, consequently ensuring its death. As I have already mentioned, it is often accompanied lower down the top or branch by the Polygraphus and by an even worse Scolytid pest described below under the name of *Cryphalus* (?) *major*, MS.

Protection and Remedies.

All young saplings infested should be cut out and burnt. In nurseries and small plantations attacked branches should be pruned close to the stem and burnt. The attack is easily discernible when the beetle is present in numbers (more especially when in company of either of the above-alluded-to beetles) as the needles turn yellow and there is an exudation of resin from the entrance holes.

Points in the life history requiring further observation.

1. Number of generations in the year.
2. Length of time spent in the various stages of the metamorphosis—egg, larva, pupa, and beetle — in each generation.
3. In which stage is the winter passed ?

CRYPHALUS (?) MAJOR, MS.

THE LONG-NEEDLED PINE LARGE CRYPHALUS.

Plate XVII, fig. 1, a, b, c, d, g.

Reference:—Provisionally named as Cryphalus (?) major, MS.

Classification:—Order, COLEOPTERA. Family, Scolytidæ.
Sub-Family, Tomicini.

Tree attacked:—*Pinus longifolia.*

Description.

Beetle.—General colour black or brown; surface densely clothed with light yellow hairs. The club of antenna is oval, narrower above, and with 4 articulations. Funiculus is five-jointed. Thorax slightly broader than long.

The male and female are, I think, of different colours. ♂. Yellowish-brown in colour. Thorax with prominent spiky spines on its upper two-thirds. The lower third and elytra pitted. Insect covered with whitish hairs.

♀. Black, shining, the upper two-thirds of prothorax covered with a dense felted mass of yellow hairs and with a few spiky spines. Lower third of prothorax and the elytra pitted and clothed with dense short yellow hairs and a few lighter coloured longer ones. Length $\frac{1}{18}$th inch. In the specimens obtained the ♀ appears to be somewhat larger than the ♂. Pl. XVII, fig. 1, a, b, shows the ♂ and ♀ of this insect.

Life History.

This beetle is the larger of the two species of Cryphalus which have been found attacking the *Pinus longifolia*. It is often to be found in the smaller twigs of the tree in company with its more minute companion *Cryphalus longifolia*, but it goes lower down these branches and also attacks the main stem as well as the side branches of saplings. It apparently prefers dying but still green trees.

The insect was found at the end of the first week in June burrowing into branches of old trees in which it was laying its eggs. A shallow irregularly-shaped chamber is first bored in the sapwood beneath the bark, both ♂ and ♀ beetles taking their share in this work, both having entered the tree by the same hole. (See Pl. XVII, fig. c, d, (p)). After the preparation of this chamber, it is probable that fertilization takes place and the ♂ beetle then leaves the tree to die. When attacking small branches the ♀ now bores a tunnel vertically down into the sapwood, either at the centre or in a corner of the pairing chamber, fig. 1, c, d (f), until it reaches the pith of the branch; she then mines out a gallery (fig. 1, c, d (e)) running in the longitudinal axis of the branch and at right angles to her former direction and about ½ an inch in length on either side of the vertical bore. The eggs, I think, are probably laid in this tunnel, and the larvæ perhaps mine up and down both ways, but this latter has to be corroborated by further observations. In one or two instances it was noticed that the ends of the gallery in the pith were blocked up with plugs of what appeared to be chewed up pith in which the eggs may have been laid. When the female is disturbed in the pairing chamber, in which she apparently lives for some time after egg-laying, she at once retires down into the gallery in the pith by the vertical boring (f). In the case of larger branches only the hole at one side of the pairing chamber and the egg galleries, which are usually curved and branching, deeply groove the sapwood (see Pl. XVII, fig. 1 d). Indentations at irregular intervals are cut in the sides of the egg-gallery in which the eggs are laid. The larvæ feed almost entirely in the bast in which the larval galleries are bored. Figure 1, g, shows a portion of a branch badly attacked by this pest in which the galleries are so interlaced as to render it difficult to decipher them. This is the usual appearance of old attacks in the forest.

As this Cryphalus lives at a somewhat low elevation in hot valleys (the altitudes at which it was found were between 2,500 and 3,000 ft.), it is probable that the June beetles observed egg-laying were laying the eggs of the second generation of the year. Just a month later, however, in the first week in July, beetles were observed again egg-laying, this time all the pairing galleries and many of the mother egg-galleries having been already prepared. No ♂ beetles were found at this period. This means that either the June-July generation is run through in all its stages in a month or what is perhaps more probable that there are several generations of these insects in the year and that the different life-cycles overlap.

From some branches taken down to Dehra (elevation 2,000 ft.) the writer obtained beetles in the middle and third week of September and others about the end of the first week of October.

Locality from where reported.

Found plentifully in the *Pinus longifolia* forests in the Tons Valley, Jaunsar Division, N. W. Himalayas.

Relations to the Forest.

This is a more dangerous pest than its smaller companion Cryphalus since its galleries and boring operations are on a more extensive scale. Saplings and branches of older trees heavily attacked by the beetle lose their needles, which first turn yellow and then drop off. An examination will show circular entrance holes large in comparison to the minute ones made by the smaller Cryphalus, and these will be seen to be equally numerous on the outer surfaces of the thicker bark as in the interstices between the flakes. The beetle would seem to prefer dying or sickly trees for its operations, and it was noticed in some abundance in portions of a forest which had been overrun by fire the previous season. The tops of many young saplings were infested with the small Cryphalus and less numerously with this one. Lower down, however, the larger one was much more numerous, many of the stems being entirely riddled by the beetles.

The beetle, since it is, as far as present observations go, invariably accompanied by *Cryphalus longifolia* and, often, by *Polygraphus longifolia* MS. as well, must be considered a serious pest in young plantations, and its life history requires fully working out.

Protection and Remedies.

Cut out and burn all young infested saplings. They may be easily recognised as the somewhat heavy foliage of the long-needled pine turns a bright yellow under heavy attacks and the trees thus become very conspicuous.

Areas which have been overrun by fire or on which sickly trees are noted to exist should be carefully watched, the trees being inspected as often as possible for external shot holes. Trees with these appearing on them should be allowed to remain for a week or two until the beetles about have all oviposited in them when they should be cut out and burnt.

During severe attacks trap trees (see p. 231) should be prepared.

Points in the life history requiring further observation.

1. Where the eggs are laid. Is it in the tunnel in the pith, in the case of the smaller branches, or are they laid in the angles of the irregular star-shaped pairing gallery?
2. Where do the larvæ feed? Is it in the bast and sapwood or in the sapwood alone or in sapwood and pith?
3. Number of generations in the year.
4. Length of the various stages in each life-cycle—egg, larva, pupa, and beetle.
5. In which stage is the winter passed?

CRYPHALUS (?) DEODARA, MS.

THE DEODAR BRANCHLET CRYPHALUS.

Plate XVII, fig. 2, a, b.

Reference:—Provisionally determined as *Cryphalus* (?) *deodara*, *MS.*

Classification:—Order, COLEOPTERA. Family, Scolytidæ. Sub-family, Tomicini.

Tree attacked:—*Cedrus Deodara* (Deodar).

Description.

The *larva* is a minute, white, curved, fleshy grub of the usual Scolytid appearance.

The *beetle* is oblong, rather shining, dark fulvous-brown to almost black in colour and covered with scattered whitish yellow hairs. Head black, concealed by prothorax which forms a hood over it. Antennæ the same colour and of usual Cryphalid form. Prothorax not broader than long, the anterior portion rather thickly studded with raised projections, the posterior half being punctate. Elytra finely punctate with longitudinal channels between the punctures. Insect entirely black beneath. Legs rufous brown. Length about 1·8 millim. (see Pl. XVII, fig. 2, a).

Life History.

The insect was discovered in all the stages of larva, pupa and beetle at the beginning of June in deodar branchlets. The beetles, just about mature and apparently ready to leave the tree, were by far the most numerous. Although the twigs contained several almost mature and mature beetles, yet externally there was no entrance hole visible on the bark, and a close inspection showed that the branchlet was girdled at or near its base. The following is the probable procedure of this beetle: The eggs are laid early in the spring sometime towards the end of April. To perform this operation the beetle seeks out a small green twig and girdles it at or near its base, the girdle being, in every case examined, complete [see Pl. XVII, fig 2, b (1)]. This girdle is made with the object of preventing further sap proceeding up the branchlet, which accordingly begins to die and thus provides a suitable supply of food for the young larvæ hatching out from the eggs laid by the beetle in the branch above the girdle. The reason why I think it probable that the branch is girdled and the eggs laid in the spring is that the young new needles of the year had developed on the ringed twig to a certain extent before they began to wither and die. Further, the wood of the twigs was still comparatively fresh instead of being dead and rotten as would have been the case had the ringing been done the previous year. The eggs are laid near the girdle and the larvæ mine up the twig [fig. 2, b (2)]. On becoming mature, the beetle bores its way out of the branchlet by a short gallery at right angles to its long axis [see fig. 2, b (3)].

An examination of many of the persistent dead twigs showed the plan of action of the beetle. Low down near the base was the girdle above but near to which the egg or eggs are laid. Inside the twig galleries will be found running up and down the wood, made by the feeding larvæ, and on the outside one or more holes of exit show where the beetles have left the stem. The larva apparently mines all round in the outer wood of the twig leaving a central core and this, in old twigs, remains often as a small hard splinter, whilst the shell of bark and wood powder crumbles to dust under one's fingers. In small twigs I never found more than one beetle, but in the larger, several were present, and in large, dry attacked twigs I noticed several holes of exit. From this I conclude that in small twigs but one egg is laid, while in the case of larger ones several eggs are deposited under the small flakes of rough bark. Whether these are laid by the same beetle or not has yet to be determined. In Plate XVII, fig. 2, b (4), a small branch is shown which has been girdled in several places by this beetle. The needles had turned yellow and were dropping off.

Area from which reported.

This insect was discovered by the writer at the beginning of June in the Nagkela Forest, Kotgarh, Bashahr Division, at an elevation of about 6,000 feet in the North-West Himalayas.

Subsequently it was noticed in several other parts of the division.

It was also independently found about the same time by Mr. R. McIntosh, Deputy Conservator of Forests, at Konain in the Jaunsar Division some hundred odd miles to the south-east.

Relations to the Forest.

As far as present observation goes, this beetle does not bore into the main stem or main side branches of the deodar, but confines its operations to the small upright needle-bearing branchlets borne on the latter on which a new flush of needles appears in the spring. Under the attack the needles on the infested branchlets turn yellow and wither and the dying twigs thus become very conspicuous on the trees. Save for this withering, the twigs show no other sign of external damage when first looked at. If taken hold of, however, they usually come off in the hand, snapping either from ½ to an inch or less (or it may be at the juncture itself) from the juncture with the main branch. A close inspection shows that the twig breaks at the point at which it has been ringed. Above the ring the newly-attacked branch is seen to be dying, and on cutting it up larvæ or beetles will be found within it. This girdling results in short, dead stumps of twigs or the dead unfallen twigs themselves being present all up the main branches, and previous attacks can be at once recognized by this characteristic. When the twigs are girdled right at the base, these visible signs are not, however, so apparent. The foliage is seen to be much thinner on the branch, and if such branches are looked at closely the scars will be seen. When the dry twigs are in exposed situations, they soon get knocked off by the wind or blows from adjacent branches; when however, they are on portions of the main branch which are more or less sheltered, they may be found persisting in numbers.

The result of this attack, more especially when combined with that of the branch-boring *Hypoborus* (?) sp. beetle described below, entails a loss to the tree of young needle-bearing twigs with the consequent decrease in the area of foliage—always a serious matter in the case of a conifer. As I have already said, the yellow rosettes of needles on the branches attacked are evidence of this beetle being at work, but an inspection is always necessary, as there are other insects whose attacks appear to produce much the same result on the tree if only cursorily examined.

Prevention and Remedies.

In the case of ornamental trees and small valuable plantations it would be comparatively easy to get rid of this pest. The attack should be carefully watched, and when the twigs are full of larvæ, *i.e.*, about the middle of May, they should be broken off and burnt. Any subsequent generations would be treated in the same manner. At present, however, it has only been found on the larger branches of old trees, and further observation is required as to whether it confines its attacks to the branchlets on old trees only.

Points in the Life History requiring further observation.

1. The number of generations in the year. It is probable that there are more than one.
2. Exactly where the eggs are laid. It is probably on the bark, as there are no entrance holes into the attacked twigs.
3. Where the winter is passed and in which stage.
4. Is the attack confined to the upright branchlets on the main side branches of the Deodar, or does the beetle also attack young growth?

HYPOBORUS (?) SP.

Plate XVII, fig. 3, a, b, c, d.

Reference:—Provisionally named as *Hypoborus* (?) sp.

Classification:—Order, COLEOPTERA. Family, Scolytidæ.

Tree attacked:—*Cedrus Deodara* (Deodar).

Description.

The larva is a very small white, legless grub. (See Pl. XVII, fig. 3, a.)

The beetle is small, oblong, black, rather shining, with head entirely concealed beneath the prothorax and not visible from above. Antennæ yellowish brown, scape thickened, longish, funiculus 5-jointed, the first long and thick; club oval, flattened, with 4 fine transverse sutures. Eyes long, narrow, transverse. Prothorax convex with a few tubercular projections anteriorly on its upper surface, and pitted on the rest of the surface posterior to this. Covered with fine bristly white hairs. Elytra cylindrical, rounded at their posterior declivity, not larger than the prothorax and pitted, the pits being arranged in longitudinal rows not close together; Third joint of tarsus slightly longer than the two above it. Body cylindrical, pubescent.

Length a little over $\frac{1}{16}$th inch. Pl. XVII, fig. 3, b, shows a dorsal and side view of this beetle.

Life History.

This small Scolytid bores into branches and twigs of the deodar, which from any cause are in a sickly or dying condition, and lays its eggs in the green bast layer. It will not touch dead twigs. The insect is almost invariably found in branches girdled by the Deodar Branch Girdler (p. 220), the girdled and dying branch being in just the condition it prefers for egg-laying.

In attacking a stem a beetle, probably the ♂, bores horizontally through the bark down to the cambium layer hollowing out a small circular or irregular-shaped chamber in the bast and wood [see Pl. XVII, fig. 2, c (p)]. The ♀ beetles enter by the same hole and are fertilized by the ♂. At this stage four beetles will be found in the chamber beneath the bark, and it is probable that the ♂ therefore fertilizes at least three females. After pairing the female beetles do not apparently bore any definite egg gallery away from the pairing chamber but merely enlarge this by eating out the bast and sapwood on one side, laying eggs in the portion so treated. The whole of the large irregular gallery thus made by the beetles, which often completely encircles the stem beneath the bark, thus effectually girdling the branch is filled with the moist chewed and passed wood refuse and excreta which fill it entirely and amongst which the eggs are evidently laid. The pairing chamber (p) in the figure shows this. The egg stage is evidently a very short one, probably a day or two only, since I have often found young larvæ in the chamber amongst the beetles and wood-dust. The larvæ bore away from the central chamber, either up or down the stem, their galleries being blocked up with wood-dust and excreta, fig. 3, b (*l*). When full-fed they hollow out at the end of the gallery a largish chamber in the sapwood and pupate in it [fig. 3, b (m)]. When boring their egg-chambers, the beetles commence work in opposite angles of the pairing cavity. The first beetle to enter the branch generally. does so just below the juncture of two branches. In the subsequent boring operations the branch is often completely girdled below the fork, the chamber being extended up one or both of the arms above it.

This insect is to be found boring into deodar branches in the first week in June, and the beetles evidently take some time over egg-laying since the first developed larvæ are to be found in the chambers whilst the beetles are still at work. It is not yet known whether this is the first or second generation of the year. There is evidently a later one, as on October 24th I obtained some nearly mature beetles from girdled deodar branches collected in the Jaunsar Division at the end of June. These beetles had evidently matured from the larvæ hatching from the June eggs. These October beetles hibernate through the winter in this state.

Locality from which reported.

This insect was discovered by the writer in the Jaunsar Division in the North-West Himalayas.

Relations to the Forest.

The beetle appears to be fairly numerous and is of some importance in the forest owing to the fact that it only attacks and lays its eggs in the green cambium of the deodar. It is thus a source of danger to young plants whose vitality has become temporarily reduced. It is an active scolytid flying readily, a habit somewhat unusual in the family. It apparently moves about in swarms since it can often be found plentifully in sickly branches or tops of young trees and in the branches girdled by the girdling scolytus. In this latter case it must be carefully distinguished from the *Scolytus deodara* the beetle which is the real author of the girdled branch (see p. 220). The small entrance holes of the *Hypoborus* will be found higher up the girdled branch generally situated at the nodes and encircled by a small ring of resin. In the case of old attacks they can be distinguished from the exit holes of the Scolytus beetles by the much larger size of these latter. It is important to remember that the girdling scolytus beetle only rings the twig, lays her eggs at the girdle, and then leaves the branch. If this is borne in mind, there will be no difficulty in attributing the damage done in either case to the proper quarter. Of course when the smaller beetle attacks and lays its eggs in branches already girdled by the Scolytus girdler, it does no damage.

Protection and Remedies.

The danger from the attacks of this insect is to some extent minimised by the fact that whenever possible it appears to oviposit in the branches girdled by the deodar branch girdler. When, however, young growth is attacked, infested trees should be cut out and burnt as soon as the needles on the infested tops and branches are seen to be turning yellow.

Points in the life history requiring further observation.

1. When does the insect make its first appearance in the year?

2. How many female beetles are fertilized by the ♂ and the number of eggs laid by each.
3. The length of time spent by the larvæ tunnelling in the twig.
4. The length of time spent in the pupal and beetle stages.
5. The number of generations in the year.

TOMICUS LONGIFOLIA, MS.

THE LONG-NEEDLED PINE TOMICUS.

Plate XVII, fig. 4.

Reference :—Provisionally determined as *Tomicus longifolia*, MS.

Classification :—Order, **COLEOPTERA**. **Family, Scolytidæ**.
Sub-Family, Tomicini.

Tree attacked :—*Pinus longifolia*.

Description.

Beetle.—Smaller than the Blue Pine Tomicus (*Tomicus* sp.) and of a very dark ferruginous brown in colour with rufous brown longish hairs scattered irregularly over prothorax and elytra. The insect has the characters common to Tomicus beetles, and from these it is recognized as such. There are five teeth on either side of the apical excavation at the apex of the elytra, the 2nd and 3rd from the top being the largest. The specimens obtained were however in too poor a state of preservation to make further description possible.

Length $\frac{3}{16}$ inch or a little more. Pl. XVII, fig. 4, gives a side view of the teeth at the side of the apical excavation showing how this insect differs from the Blue Pine Tomicus.

Life History.

I have as yet only found dead specimens of this beetle in galleries beneath the bark of dead trees. It differs from the Blue Pine Tomicus both in appearance and in its method of tunnelling in the bast and sapwood of the tree.

This Tomicus bores a straight horizontal entrance hole into the tree until it reaches the cambium where a large pairing chamber is excavated. From this four long egg galleries take off. In the specimens examined, two of them went up the tree and two down parallel to its long axis. These egg galleries, which, like the pairing chamber, are bored in the bast and sapwood, contain one or two 'air holes,' *i.e*, holes bored to the outside of the tree by the female to let air into the tunnel.

The eggs are placed in indentations in the sides of the egg galleries, and the larva apparently bores its gallery mainly in the bast and not in the sapwood.

I know nothing further about the life history of this insect.

Points in the life history requiring further observation.

1. At what time are the first eggs of the season laid? They will probably be deposited in fresh living bark of sickly or felled trees.
2. The number of beetles with which the ♂ pairs.
3. Is more than one egg gallery bored by any one female?
4. The number of eggs laid by each ♀.
5. Length of time spent in the larval stage.
6. Length of time spent in the pupal stage.
7. The number of generations in the year.
8. Where the insect passes the winter and in which stage of its metamorphosis, egg, larva, pupa, or beetle.

ECCOPTOPTERA SEXDENTATA, MOTS.

THE SILVER FIR BRANCH GIRDLER.

Plate XVII, fig. 5.

Classification:—Order, **COLEOPTERA**. Family, **Scolytidæ.**

Tree attacked:—*Abies Webbiana, Lindl.* (The Silver Fir.)

Description.

Imago ♀. The specimens obtained were not quite mature though fully developed. The beetle is bright yellow brown in colour all over but darkening slightly on dorsal surface of the elytra. Head projects beyond thorax. Antennæ angled and knobbed; funiculus 7-jointed, the joints increasing in size upwards, the top one being large; club blunt-oval. Head and prothorax one-third total length of insect. Elytra are toothed at their extremities, truncate and together with the prothorax uniformly pitted all over. Longish scattered yellow hairs are present on the dorsal surface of the insect Front coxæ contiguous; tibiæ toothed on their outer edges When fully mature, the beetle would doubtless be a dark brown or black in colour. Length 3 millim. Pl. XVII, fig. 5, shows a dorsal and side view of this insect.

The male insect is quite different in appearance.

Life History.

The flight time of this beetle is probably about the first fortnight in July. The ♀ lays her eggs in the pendulous side branches of the silver fir. These branches are ringed by the insect. I am not at present able to say whether the ♂ beetle helps the ♀ in this work, as I have not yet found the former. The girdle is made about a third of the length of the branch down from its upper extremity, the ringing being done just above a node, *i.e.*, the point of juncture of small offshoot side branchlets. The egg or eggs are apparently laid above the ring, generally just above it. The object of the girdle is to kill the portion of the branch above and thus provide a supply of dying wood for the larva to feed upon. The larva on hatching out bores up the branch mining out a fairly deep gallery in the sapwood. This gallery may be straight or may curve about but always goes up the branch. The wood consumed by the larva is passed out at its anal extremity and fills up the part of the gallery it has already gnawed out. When full fed, the grub enlarges the top of the tunnel forming a pupal chamber and presumably pupates in this. It is in this enlarged chamber at the head of the gallery that the beetles were obtained, in every case the gallery below the chamber being invariably blocked up with the wood excreta of the larva. There are no offshoots to the tunnel. In some cases I noticed that branches were ringed in several places at successive nodes. In each case a gallery was present above the girdle. Whether this was the work of the same beetle or of different ones I was not able to determine. In none of the galleries from which beetles were obtained was any opening to be seen on the outside of the branch, the girdle and the dying or dead condition of the branch being the only external evidence of the beetle's work. Branches attacked in previous years showed, however, in the cases where the dead portion above the girdle had not already been knocked or dropped off, a small round hole of exit communicating with the outside from the pupal chamber, and it is evident that the beetle leaves the branch by boring horizontally through the bark.

I am at present unable to state whether this beetle has more than one generation in the year. I found on the 5th July two newly-ringed branches, and it is probable that the beetle lays her eggs soon after issuing, about the middle of the month.

Locality from which reported.

This beetle was found in Silver Fir (*Abies webbiana*, Lindl.) in a forest near Baghi in the Bashahr State in the North-West Himalayas, at an elevation of about 8,000 feet.

Relations to the Forest.

The damage done is to the side branches of the silver fir. The beetle rings these at a point generally about two-thirds to three-quarters up from where they leave the main trunk. The portions above the ring die and the effect, whilst causing a certain loss of branches, and consequently leaf-area to the tree, gives it a scraggy appearance, the ends of numbers of the branches being in a dead or dying state.

Protection and Remedies.

When attacks of this nature take place in nurseries, plantations, *etc.*, a feasible plan of getting rid of the beetles is to carefully collect all the portions of the twigs and branches above the rings and burn them. If this operation is done carefully and at the proper time, *i.e.*, when they contain larvæ or pupæ, it will stamp out the pest.

Points in the life history requiring further observation.

1. Exactly where the eggs are laid by the female above the girdle. Is more than one egg laid above any one ring?
2. Length of time spent by the larva feeding in the branch. From the amount of wood consumed and the size of the gallery made, I am of opinion that it will not improbably be found that several months are spent in this stage.
3. Length of time spent in the pupal stage.
4. Number of generations in the year.
5. The male beetle has still to be found. Does it help the female in the girdling work?
6. In which stage does the insect pass through the winter?

HYBLÆA PUERA,

CRAM.

Plate XVIII, fig. 1.

References:—Cram. Pap. Exot., pl. 103, figs. D, E; C. & S. no. 2232; Moore Lep. Ceyl., iii, pl. 154, figs. 2, 2(*a*) (larva); Noctua saga, Fabr. Mant. Ins. ii, p. 137. Noctua unxia, Hübn. Eur. Schmett., Noct., fig. 513.; Heliothis apricans Boisd. Faun. Ent. Madag. p. 98, pl. 15, fig. 7; Hmpsn. Faun. Br. Ind. Moths, II, 371 no 2204; Steb. Inj. Ins. Ind. For., 115—117. fig. 71.

Classification:—Order, LEPIDOPTERA. Sub-order, HETEROCERA. Family, Noctuidæ.

Tree attacked:—*Tectona grandis* (Teak).

Description.

Larva.—The general appearance of the larva is black above and yellow or green beneath. The dorsal colour, however, of the last 11 segments varies from black to a dark purple-grey. A broad reddish or flesh-coloured stripe runs down the median dorsal surface, bordered on either side by a narrow, white line. Another lateral white line is usually present on each side just above the junction of the upper black with the lower yellow colour. The head and first segment are black. On the dorsal surface of the last segment but one there is a white transverse mark which is very constant, being invariably present in the very numerous specimens examined. Body covered with scattered hairs. The larva tapers towards both ends. Length 1 to 1½ inches.

I am at present of opinion that it is probable that the young larvæ are of a uniform purple-grey or black in colour, as I have not yet seen quite small larvæ with the flesh-coloured dorsal stripe or yellow ventral colouring. It may be, however, that the young dark-coloured larvæ seen are those of the black variety of Hyblæa described below.

The larva spins a rough, loose, silken cocoon to pupate in.

Pupa.—A bright chestnut brown in colour with a yellowish tinge. Darkens slightly after a day or two, but the colouring remains uniform throughout. The pupa is thickish with blunt ends. Length ½ inch or, at times, a little over.

Moth.—Head very small and antennæ minutely ciliated in male. Head and thorax greyish red-brown; abdomen black-brown with orange segmental bands. General colouring of upperwings greyish red-brown whilst the under-wings are black-brown with orange and scarlet blotches. Fore-wing greyish red-brown, irrorated with a few dark specks. Hind-wing black-brown, with a curved orange band with scarlet edges from upper angle of cell to near anal angle; a band on the margin from vein 2 to anal angle. Underside of fore-wing black, with orange fascia in cell and far beyond it; the costa and apex pale brownish with dark specks; the inner margin yellow Hind-wing pale brownish with dark specks; orange towards anal angle, with two large black spots.

Expanse of wing 32—40 millim. Fig. 71 in *Injurious Insects* shows the larval, pupal and imago stages of this moth.

Life History.

This insect, whose larvæ defoliate the teak tree, passes through a large number of generations in the year, the number at times reaching seven life cycles according to Mr. T. R. D. Bell. It thus resembles in this respect its companion *Pyrausta machœralis* with whom it is generally found on the trees. The time of appearance of the larvæ is not fixed in any way, as there is a continuous series of generations as long as the leaves remain upon the trees. It is probable that these generations overlap to a certain extent, but I do not know whether this is so marked as in the case of the Pyrausta.

The larval stage lasts about 19 days and the pupal from 8 to 11. These periods will of course vary in different parts of the continent, and on the Bombay side it is considered that from egg to moth takes about six weeks.

The stage in which the insect passes through the winter has not yet been observed, but the first larvæ make their appearance in South India, and probably also on the Bombay side, in April-May, this being the period at which they are also first seen in Burma. In the drier teak forests the attacks would not begin before July, and the number of generations passed through in the year will be reduced to 3 or 4. Mr. Bourdillon considers that in Southern India, either very dry or very wet weather is detrimental to the spread of the insect.

The larva feeds upon the leaves, and, when full grown, pupates in various ways upon them—

1. Either amongst the dead leaves on the ground in which it spins a flimsy cocoon, changing into a pupa within this.
2. Pupates upon a leaf on the tree and may drop to the ground with it if it is a dying or dead one.
3. Occasionally spins its cocoon over the mid-rib of the leaf, dragging the sides of leaf together by means of silken threads.
4. Folds the edge of a leaf, which it may cut into a short way for the purpose, over and binds it together with silk, pupating within it.

A very interesting case of the pupation of this pest was noticed in the Yeni Reserve, Pyinmana, Upper Burma, by Mr. Cubitt. The attack of the larvæ took place in a high teak forest having an undergrowth consisting almost entirely of a dense mass of young bamboo (*Cephalostachyum pergracile*) about 4′ 6″ in height. On becoming full fed, the larvæ let themselves down by silken threads on to the undergrowth and the pupation took place in the bamboo leaves. These latter were not merely rolled up at the edges, but were folded like a sheet of note paper more or less transversely and usually 2″ from the apex. In this instance the larvæ did not pupate upon the ground, probably owing to the undergrowth having been too dense for them to get through with ease. Another point noticed by Mr. Cubitt was that only the tallest trees in the teak forest were attacked and defoliated: poles and saplings invariably escaping except perhaps in their upper branches. I can give no explanation for this, as the larvæ usually attack young and old trees indiscriminately.

Localities from where reported.

This insect has a wide distribution, present reports showing that it is to be found practically wherever teak forests occur in India and Burma. The writer has found the insect in Bombay, Berar, Central Provinces and Madras (Coimbatore and South Malabar forests).

Hampson gives the distribution as :—

West Indies; South Africa; throughout India, Burma and Ceylon; Java; New Guinea; Cape York.

Relations to the Forest.

This insect, together with its companion *Pyrausta machæralis,* form perhaps two of the most serious pests the teak tree has to contend with in India, since almost every year, and on occasions several times during the year, one or other or both together, partially or entirely strip the leaves from the trees. The method of feeding of the *Hyblæa* caterpillar on the teak leaf is very characteristic, and apparently would not appear to vary: it is quite distinct from that of the *Pyrausta.* The larvæ attack and consume all the green tissue of the leaf, only leaving untouched the main rib and chief side ribs. Young poles and saplings have been seen with their entire crop of leaves treated in this remarkable manner, only the mid-rib and chief side ribs of the leaf, with here and there attached to the rib a small green portion of the leaf tissue, remaining uneaten (see Pl. XVIII, fig. 1, and compare with fig. 2 in the same plate). This method of attack is so marked that there is no difficulty in recognizing at once the presence of the larvæ in a forest, even if the caterpillars are not themselves visible. These latter, after the fashion of most Noctuids, have a habit of concealing themselves during the heat of the day, probably doing a great deal of their feeding at night. It will of course be understood that it is only in the more severe attacks that one finds almost the entire crop of the leaves treated in this manner. In lesser attacks only a portion of the leaf may be eaten and the larvæ may then go on to another one. In every case, however, the tissue will be eaten down to the rib and the rib left untouched.

Opinions seem to conflict at present as to whether this insect is more injurious in pure than in mixed teak forests. In Burma Mr. S. Carr, Deputy Conservator of Forests, states that "the damage is certainly more severe in pure teak than in mixed forest because more trees are attacked." My own observations in the case of young pure teak plantations have shown me that the insect is capable of doing a large amount of damage in such and undoubtedly does so at Nilambur. In older mixed forests, in some parts of the continent, on the other hand, the insect is able to increase at times equally in the mixed as in the pure teak since it does not confine itself to the teak tree alone, but is fairly omnivorous feeding in Kanara on species of Dherries (*Leguminosæ*), while in Berar I noted that it often completely defoliated a Bauhinia. There may be two principal attacks of this pest during the year, the first occurring about May in the damper teak forests and July in the drier ones. Mr. S. Carr states that in the Southern Burma Plantations of the Rangoon Division this attack lasts from May to July but remarks, "though the attack extended over a considerable period, there is nothing to show that it was caused by more than one generation of the larvæ." From what we know of the life history of the insect, I think it probable that it will be found that at least two generations of the insect are passed through in this period. The second serious defoliating attack takes place between September and November or December Unfortunately the attacks have been by no means noted so exactly as in the case of the *Pyrausta* ones, and we have much to learn about the periodical increases of this pest. One fact is certain, however, and that is, that it is to be found in the teak forests between the end of April to November and December, and there appears to be no reason against any one of the seven generations increasing above the normal and in such numbers as to be capable of stripping the forests entirely. I noted that the young teak from 1-5 years old in the Karimpoya Plantations at Nilambur were being very seriously defoliated towards the end of August. Numbers of the young saplings were leafless or rapidly becoming so, resulting in complete stoppage of growth of the young plants in the middle of the growing season—a most serious matter. I also noticed that here and there young saplings had dried up and died and a careful inspection revealed no external or internal reason for this state of affairs. It may have been due to constant defoliations by this insect and *Pyrausta*, the successive flushes of leaves having been regularly eaten off.

Further observations require to be made and records kept of the results of the constant defoliation due to the attacks of these two pests, but two resultant causes to the trees are—

1. The entire loss of leaves stops growth, and, if occurring in the flowering season, when the trees are in full flower, not unlikely has a serious effect upon the production of seed and the consequent natural regeneration of the forest.
2. A serious loss of increment in the annual amount of wood put on by the tree and therefore a serious delay in time in reaching the required cutting standard of girth.

It would appear not unlikely that the successive stoppages in growth resulting from these attacks will give several rings of wood per year instead of the one annual one only. Enquiries are being conducted with the view of ascertaining this point.

Protection and Remedies.

I have given a full note upon possible protective methods under *Pyrausta machœralis* below.

In the case of the Hyblæa the matter is not so easy, since we have no information at present as to where and in which stage the insect spends the winter. It would appear that a very considerable number of the larvæ of the spring to autumn or active generations pupate in the leaves of the trees (contrary to the practice of many Noctuids which pupate in the soil), but it may be found that a portion at least pupate in the soil. Mr. Bourdillon, writing of the attacks of this pest in Travancore, says that the first sign that the caterpillars are going to be numerous is indicated by the edges of the teak leaves being folded over here and there for a length of a third of an inch and a depth of a ¼ inch. Inside a minute caterpillar will be found. The ragged appearance of the teak leaves is therefore the first warning of an impending severe attack. It will generally, I think, be found that the larvæ feed in this manner at first, if not also in the later stages of their existence ; the ribs in the rolled-over portion are never however eaten. In nurseries it will be possible to cut off the rolled-up edges in which the larvæ have pupated and burn them.

Points in the life history requiring further observation.

1. The exact number of days passed in the egg stage in the various generations.
2. Where the eggs are laid. Is it upon the leaves as in the case of *Pyrausta* ?
3. Where the larvæ of the various generations pupate. Do they pupate in the soil as well as in the leaves ?
4. The time spent in the moth stage.
5. Where and in which stage is the winter passed through? Is it as hibernating larvæ or pupæ in an earthen cocoon in the soil ?
6. The periods in the year during which the most serious defoliating attacks of the pest are experienced in different parts of the country. [With reference to this point see remarks on page 311 under *Pyrausta.*]
7. The effect of the attack upon—
    1. The flowering and seeding of the teak trees.
    2. The increment and annual rings. Are false rings found ?

Parasite upon *Hyblœa puera*.

Tachinidæ.

A fly belonging to this family, the species being as yet undetermined, was bred out of some *H. puera* larvæ obtained by the writer from the Karimpoya Teak Plantations, Nilumbur, on the 28th August. The fly issued from the small, blunt, elliptical black pupa case between the 5th and 10th September, a small lid or cap at one end splitting off. Further information is required on the life history of this parasite.

HYBLÆA PUERA, var. NIGRA, MS.

THE BLACK HYBLÆA.

Plate XIX, fig. 1, *a*, *b*, *c*.

Reference:—Provisionally named as *H. puera*, var. nigra, MS.

Tree attacked:—*Tectona grandis* (Teak).

Description.

Larva.—Head large, hard, shining, black; prothorax black, duller than head, also hard and chitinous, each with a few black hairs scattered over them. Rest of segments a soft velvety black with a few scattered white hairs taking off from small tubercles situated on the body. Last segment small, chitinous, dull black with large black anal claspers. The short transverse white streak present on the dorsal surface of the 11th segment of the true *H. puera* larvæ is present here. Ventral surface in full grown specimens orange, the thoracic and pro-legs being of the same colour. A black irregular wavy line runs down just above the pro-legs on either side from segments 4 to 11 inclusive. Thorax on ventral surface black as also is 12th segment. Stigmata white, small, elliptical, placed just above junction of the black and orange colour. A few scattered hairs on the under-surface. The body is thickish in middle, tapering to either end. In younger specimens the body beneath is almost a greenish white, a narrow white line separating the black from the under-surface colouring. Length 1¼ to 1⅝ inches. Pl. XIX, fig. 1, *a*, shows a dorsal and side view of this larva.

Pupa.—The larva spins a loose white silk pupal covering before changing to the pupa.

The pupa is at first a bright canary yellow or yellow green anteriorly, the head and thoracic portion being considerably thickened and enlarged. Dorsally 4 body segments can be seen below the thorax, the last tapering to a point. Ventrally nine segments can be counted. These are a pale yellowish brown in colour, the constrictions between the segments being pale yellow. The whole pupa subsequently darkens, becoming shining black, the constrictions between the abdominal segments being banded with red, the segments themselves being finely striated transversely. The antennæ, eyes, proboscis and legs of the future moth can be distinctly seen upon the outside of the pupal case forming swellings and ridges. The pupa tapers from the anterior end downwards. Length $\frac{3}{4}$ inch. Width across upper end $\frac{7}{32}$ inch. Pl. XIX, fig. 1, *b*, shows the pupa in its silken cocoon spun amongst the leaves.

Moth.—Has a great resemblance to that of *Hyblæa puera*, but is much stouter in build. Mr. N. Brodie, C.S., considers it to be a "curious variety, most of the ♀'s having a triangular brown patch at the tips of the forewing, like those possessed by *constellata*, but the shape of the forewing and the presence of the two black spots on the underside of the hind-wing at the anal angle instead of one shows it to be *puera*." Pl. XIX, fig. 1, *c*. shows the male, and *d* the female of this insect. The moth varies in size but the specimens I obtained have about the same wing expanse as *H. puera.*

The above descriptions of the pupa and moth show that they differ from those of *Hyblæa puera* to a certain extent. On the other hand, the larva is similar in possessing the white transverse dorsal streak upon the 11th segment and yet totally dissimilar in colouring on the dorsal surface. It is also longer.

The dissimilarity in the larva, pupa and moth have led me to place this insect temporarily as a variety of the true *Hyblæa puera.*

Life History.

As far as is at present known, this variety has only been reported from the Nilambur Teak Plantations and from the plantations in the Rangoon Division in Lower Burma. It was apparently plentiful at Nilumbur during July since specimens sent for identification to Mr. N. Brodie at Calicut proved to be this insect. I found it very plentiful towards the latter part of August in the Panangode, Aravallikavu and Edakode Plantations. In the latter it had, in company with Pyrausta, completely defoliated portions of some young 8-year old plantations—not a leaf being left upon the trees. The caterpillar is larger than the ordinary *H. puera* one and is a voracious feeder. Its method of pupation is the same as already described for the latter. In the figure 1, *b* the pupa is shown spun on to a leaf. The pupal state lasts from 7-9 days in the case of the August generation, and a generation would appear to take about 5-6 weeks to run through. In fact, the life history, method of feeding, etc., appear to be identical with the true *Hyblæa*, the only difference between the two insects being in the size and markings of the larva, pupa and moth. This is however very marked.

In Burma from where it was also reported for the first time this year it was very plentiful in July but does not have appeared to have reoccurred in August.

Locality from where reported: Relations to forest, etc.

This variety of *Hyblæa* has been reported from the Nilambur Teak Plantations in India. It has also been sent from the Rangoon Division in Burma by Mr. S. Carr where it apparently defoliates teak in company with *Hyblæa puera* and *Hyblæa constellata*. Its method of attacking the foliage and behaviour in the forest, etc., are the same as already described under *H. puera*.

Points in the life history requiring further observation.

1. The number of generations in the year (this is important) and the length of time spent in the various stages of egg, larva, pupa, and imago in each.
2. Where the eggs are laid. Is it on the branches and round the axils of the buds as is usual with noctuid moths?
3. Where the insect passes the winter and in which stage.
4. Does it feed upon other trees besides teak? I believe this to be the case.

Parasites upon *Hyblœa puera*, var. *nigra*, MS.

1. *Ichneumonidæ.*

The caterpillars obtained in August were found to be parasitised to a certain extent by several different insects as well as by a fungus.

(1) A small hymenopterous grub was watched feeding as an external parasite on one of the full-grown larvæ. The cater-

pillar was killed by it, the hymenopterous larva becoming full fed in four days. I have not yet obtained an imago from the pupa.

(2) Two species of Ichneumon flies both bred out of larvæ which had pupated. These are as yet unnamed.

2. *Fungi.*

The caterpillars are attacked by a disease which in its effects appears to produce the same results as the 'flacherie' of the silkworm. The disease in question is produced by a fungus which I hope to submit to Dr. Butler for identification. The larvæ become flaccid and wet, cease feeding, and die before pupating.

HYBLÆA CONSTELLATA,
GUEN.

References: -Guen. Noct. ii, p. 391; Moore, Lep. Ceyl. iii, pl. 154, figs. 3, 3*a*; C. & S. no. 2230.

Classification: -Order, **LEPIDOPTERA**, Sub-order, **HETEROCERA**. Family, **Noctuidæ**.

Tree attacked:—*Tectona grandis*, Lin. (Teak).

Description.[1]

Larva.—Mr. Carr thus describes it:—"About 1 inch or rather longer. Dark greyish below, velvety black above with, in some cases, a tendency towards a purplish or bluish tinge. Along middle of back a very faint line is sometimes to be found with a faint line of tiny, whitish, spots on each side; at junction of back and belly a number of uneven whitish yellow blotches forming a broken streaky line; head black; emits a black fluid from both ends when disturbed and frequently drops to the ground; rather more hairy than No. 1." Mr. Carr's No. 1 I identify as similar to my *Hyblæa puera*, var. *nigra* larva.

Pupa.—Mr. Carr describes the pupa as similar to that of its companion identified as *H. puera*, var. *nigra*.

Moth.—Easily distinguishable as *H. constellata* by its dark olive-green head and thorax, and by having the fore wing with the outer margin excised below the apex and excurved at the centre, whereas in the other two above described species the outer margin of fore wing is not excised below the apex and is evenly curved. The abdomen is black, with orange segmental rings and crimson at sides towards the extremity. Fore wing dark olive-green with dark specks; often with two antemedial yellowish white diffused patches; a subapical bar, and brown apical patch in the upper angle. Hind wing black-brown, with two orange spots beyond lower angle of cell and two towards anal angle. Underside of fore wing black, with the costa and inner margin orange; the base of cell, a band at end of it, and one beyond it orange. Hind wing orange, suffused with crimson and with numerous black spots; a black spot at anal angle.

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[1] This is as far as I am aware, the first time this insect has been reported as seriously defoliating teak. The specimens were collected and the observations made by Mr. S. Carr, F.C.H., Deputy Conservator of Forests, in the Rangoon Division. Unfortunately the moths sent were not actually bred from described larvæ. Three different *Hyblæa* moths have been sent to me, and as the descriptions of two of the larvæ show them to be those of *H. puera* and *H. puera*, var. *nigra*, I take the third larva present to be that of *H. constellata*. This requires further verification however,

Expanse 34-40 millim.

In general build and appearance it resembles the figure of *Hyblæa puera*, var. *nigra*, shown in the plate.

Life History.

This insect was found by Mr. S. Carr seriously defoliating teak plantations in the Rangoon Division in June-July 1902 Mr. Carr states that it defoliates the trees in a similar way to the larvæ of the moth *Pyrausta machæralis*, *i.e.*, by eating only the soft parenchyma and thus skeletonizing the leaf. This statement is one of considerable importance and requires careful extended observation since it has been up to now supposed that this method of defoliation was peculiar to *Pyrausta machæralis*. Mr. Carr mentions observing large numbers of small yellowish moths about the same time in the plantations, and these are not at all unlikely to have been those of *P. machæralis*, in which case this skeletonizing may have been done by the larvæ of these moths, they having all pupated before they were noticed at work. Further, it may be that the *H. constellata* larvæ feed upon the soft parenchyma in their younger stages of growth. This point requires careful observation and a careful comparison of leaves defoliated by the two larvæ.

The June attack was a serious one as it spread over 900 acres of plantation. The damage was said to be unevenly distributed and appeared to be the result of numerous separate attacks, each commencing at a centre of its own and extending irregularly in all directions to a distance limited only by the life of the caterpillars. The larvæ of this June attack are said to have pupated on the leaves, enormous numbers of pupæ being seen; besides teak leaves, the leaves of the wild plantains and the spring leaves of canes were made use of. No cocoons were found on the dead leaves upon the ground.

Locality from where reported.

Mr. S. Carr has recently reported this moth from the Rangoon Teak Plantations as a serious teak defoliating pest. Hampson gives the distribution as:—China; throughout India, Ceylon, and Burma; Malacca; Borneo; Australia.

Its relations to the forest and methods of protection against it are the same as already given for *Hyblæa puera.*

Points in the life history requiring further observation.

1. The number of generations in the year. This is important.
2. Is the larva described above the larva of the moth *H. constellata?*
3. Where the eggs are laid.
4. Where the insect passes the winter and in which stage.
5. Length of time passed in the various stages of its metamorphosis.
6. Does it attack other trees besides teak?

PYRAUSTA MACHŒRALIS,[1]

WLK.

Plate XVIII, fig. 2 ; Plate XIX, fig. 2.

References:—Wlk. Cat. xix, p. 1013; C. & S. no. 4152. *Scopula damastesalis*, Wlk. Cat. xix, p. 1013; Hmpsn. Ill. Het. ix, pl. 173, figs. 1-8; Cotes, Ind. Mus. Notes iii, p. 94 (larva), C. & S. no. 4147; *Botys egenalis*, Led. Wien. Ent. Mon. vii, pp. 372-468, pl. 10, fig. 7; *Botys suavalis*, Wlk. Cat. xxxiv, p. 1448; *Asopia rufipicta*, Butl. P. Z. S. 1880, p. 682; *Paliga fuscicostalis*, Swinh. A. M. N. H. (6) xiv, p. 146; *Ebutea fimbriata*, Moore, Lep. Ceyl. iii, p. 346; C. & S. no. 4135; *Paliga rubicundalis*, Warr. A. M. N. H. (6) xvii, p. 96; Hmpsn. Faun. Br. Ind. Moths. iv, 432, no. 5321; Steb. Inj. Ins. Ind. For. p. 119, fig. 72.

Classification:—Order, **LEPIDOPTERA.** Sub-order, **HETEROCERA.** Family, **Pyralidæ.**

Tree attacked :—*Tectona grandis* (Teak).

Portions of the following descriptions and notes on the life history are from an excellent and valuable paper on this insect by Mr. R. S. Hole, Deputy Conservator of Forests. Mr. Hole, I believe, intends to publish his paper *in extenso* in a future number of the Journal of the Bombay Natural History Society.

Description.

Egg.—The eggs are small, round, greenish, gelatinous bodies, which are usually laid singly on the backs of the young teak leaves close to a rib or small vein.

Larva.—The full grown larva is elongate. Its length varying from 0·83 to 0·98 inch and its mid diameter from 0·08 to 0·11 inch. It is sap green in colour, paler below, with a series of paired dorsal purplish spots which are bounded upon either side by a yellow line, the lines running down the whole dorsal length of the grub and nearly meeting posteriorly. On

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[1] This insect is unfortunately generally known in India as *Paliga damastesalis* under which name it is constantly alluded to in *Indian Museum Notes* and later in *Injurious Insects.*

each side, below the yellow dorsal lines, are a series of light coloured lateral marks tipped with purple, these being more or less indistinct, except on the 3rd and 4th segments where they are conspicuous. Head yellow. A few erect hairs on each segment.

The larva on emerging from the egg is about $\frac{1}{12}$th inch in length and is active from the first. The colour is then a dirty white which gradually changes to pale green. The purple spots are usually not distinct until after the first change of skin, which takes place when the larva is 5-6 days old. Before the moult the marks appear as pale spots with dark specks. After the moult the larva appears with its normal markings. In three or four days a second moult takes place. Three or four days after this second moult the larva stops feeding and becomes torpid, preparatory to constructing its cocoon. The construction of the cocoon usually occupies one day, and pupation takes place inside the cocoon two days after the larva has stopped feeding. (During the winter hibernation the larva remains in the cocoon 22 weeks, after which pupation takes place as usual). Just before each change of skin the larva becomes torpid and contracts in size, the colour fading to pale yellow, in which the purple markings are very distinct (see Pl. XIX, fig. 2).

Pupa.—The larva changes into the pupal state within a loose silken cocoon. Pupa is slender. Colour yellowish-brown, dark on back, pale to white in front, with a few scattered bristles. On the top of the head, between the eyes, are two small dark bristles. At the point of tail there is a minute hook, with two outwardly-pointed branches. Length 0·52 to 0·43 inch and the mid diameter 0·09 to 0·13 inch.

Moth.[1]—Bright yellow; palpi white below; frons white at sides. Fore wing with fulvous-yellow subcostal fascia; an antemedial line oblique from costa to vein^1, where it is dentate inwards; a speck in cell and discocellular lunule; a postmedial crenulate line highly excurved between veins 6 and 2, along which it is retracted, and dentate on vein 1; a more or less prominent crenulate submarginal line.

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[1] Description from Hampson Faun. Br. Ind. Moths, p 433.

Hind wing with crenulate postmedial line bent outwards between veins 5 and 3, along which it is retracted; both wings with marginal dark line and two lines through the cilia. Mr. Hole notes that in the large number of specimens examined by him in the Central Provinces he has been unable to trace the crenulate postmedial line between veins 5 and 3.

The form *suavalis-fuscicostalis* has the marginal area of fore wing and of hind wing to vein 2 suffused with fuscous; *rubicundalis* from the Khásis has all the markings pink.

Expanse of wing ♂ 22, ♀ 24 millim.

Fig. 72 in *Injurious Insects* shows the pupa and moth of this insect.

Life History.

This insect has a large number of generations, which may be as many as seven, in the year. The time usually required to pass through one complete generation in the Central Provinces has been found by Mr. Hole to be 30 days, as follows:—

From appearance of moth to emergence of larvæ from eggs laid by the former . .	7 days.
Larval stage	16 „
Pupal do.	7 „
TOTAL .	30 „

In the Central Provinces the moths make their first appearance in the first week of April from the larvæ which hibernate through the winter. The larvæ from the eggs laid by these moths would therefore make their appearance upon the teak leaves about the beginning of the month, and the moths of the first completed generation of the year at the end of the first week in May, allowing 16 days for the larval stage and 7 days for the pupal one as given above. This coincides with what is probably the first appearance of the insect in Burma, Colonel Bingham having collected larvæ towards the end of April from which the first moths were obtained on May 6th. In the Kanara Teak forests of Bombay also Mr. Bell states that the insect has about seven generations in the year, lasting from a month to 6 weeks each, so that the pest evidently makes its appearance early in the year in that presidency. Again, in Madras Mr. Van Haepter, Ranger in charge of the Nilambur Teak Plantations in South Malabar, reports that the caterpillars first appear in April, in which month they often entirely defoliate the teak trees.

Mr. Hole notices, however, and the provision applies to other similar localities, that in the dry teak forests of the Jubbulpore and Damoh Divisions in the Central Provinces, larvæ do not appear before June and July since the trees are leafless in April-May. Mr. Bell is, however, of opinion that the larvæ may feed upon other trees besides teak on the Bombay side, and this may be the case in the Central Provinces, though Mr. Hole states he has not been able to prove it to be so.

From the time of the first appearance of the larvæ to the time when hibernation commences, one generation succeeds another without interruption, and there can be no doubt that these generations overlap since some moths will appear earlier in the spring from the hibernating larvæ than others, the caterpillars from the eggs of the former thus getting a start over the latter. All observations recorded tend to prove this to be the case. Mr. Bell writes :—" There are no set times of appearance here in Kanara; there are always a few teak trees in leaf all the year through, and there are always a few larvæ to be found in consequence." Mr. Hole has found this to be the rule in Damoh and Jubbulpore, and the writer, during the latter portion of July 1901, spent in Berar and the same period and all August of 1902 spent in the Teak forest of the Southern Circle (Coimbatore and Nilambur) in Madras, found a similar state of affairs. This means that all the stages of development of the insect, *i.e.*, egg, larva, pupa, and moth are to be found, if looked for, at the same time: the eggs on the leaves, the larvæ feeding upon the leaves, the pupæ spun up in the leaves or in dried leaves on the ground, and the moths flying about the forest and settling upon the leaves to lay their eggs.

In the Central Provinces Mr. Hole notices that the larvæ begin to hibernate about the end of October. To do this the full-fed larvæ leave the trees on which they have been feeding and proceed to construct cocoons usually, if not always, in the ground. The cocoons are made of silk and bits of earth bound together and are usually found in clusters under stones and large boulders. When there are no stones, the cocoons may be found at a depth of several inches in the soil. At the end of the hibernation in the following April the larvæ change to pupæ. This hibernating stage lasts therefore in the drier forests of the Central Provinces (Damoh and Jubbulpore) for twenty-two weeks. This period is, however, not so long in the damper forests of Kanara and the west coast of Madras (Nilambur), as in these localities the insect is to be found active till the end of December and November respectively. The hibernating period would hence appear to be from 14 to 15 weeks in the first and 18 to 19 weeks in the second case.

Method of pupation.—Mr. Hole has made a series of experiments on this head, and he has found that nearly 50 per cent. of the larva appear to ordinarily pupate on the leaves, whilst the remainder pupate either amongst the dried leaves in the soil, letting themselves down from the trees by silken threads, or in crevices of the bark, etc. In pupating on the leaf on the tree the larva may simply spin a loose silk web across the mid-rib or a lateral vein on a curved portion of the inner face of the leaf, or it may spin together a portion of the edge which thereby becomes rolled over.[1] Or the web may be spun between the lower surface of one leaf and the upper one of another in the angle made at the point where these two surfaces happen to touch one another. It pupates in the same way amongst the dried leaves on the ground. It only pupates in the ground after the hibernating stage, which stage is, as already described, spent in the ground. Mr. Hole describes the cocoon within which pupation takes place as 'thin and made of white silk, and of a shape to fit the depression in which it is constructed.'

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[1] This insect has been called the Teak-leaf roller. Mr. Hole from his observations considers this to be a misnomer. It is, however, too early to condemn the name until full observations on the method of pupation have been made in Bombay, Berar, Madras and Burma, where the insect is, in many parts, exceedingly plentiful.

We may thus say of this moth that in dry teak forests it probably runs through as many as four generations in the year, whilst in the damper forests of this tree it will have seven generations, hibernating as a full-grown larva at the beginning of November or later towards the end of December. At the same time, however, it must be noted that the actual hibernation of the full-grown larva in the ground has as yet been only noted in the Central Provinces teak forests, and observations as to whether the insect acts in this manner have still to be made in the other parts of India where teak grows. It need hardly be stated here that this point is an exceedingly important one since it may possibly prove to be the easiest stage in which to attack the insect.

Localities from which reported.

This insect has a wide distribution, and, as this latter shows, must have other food-plants besides teak. In India reports show that it is present wherever the teak tree grows, and this would appear to apply to single scattered introduced trees since there are a few such in Dehra Dun, and the insect is present upon them. The distribution in India may be given as the teak forests of Bombay, Berar, Central Provinces, Madras and Burma.

Hampson gives the distribution as—

Formosa, Khasis, Nilgiris, Ceylon, Burma, Java, Australia.

Relations to the Forest.

This Pyrausta is at present one of the most serious defoliating pests known in Indian forests. Another which is equally bad is its companion *Hyblæa puera.* The method of feeding of the caterpillar is eminently characteristic and apparently never varies. The damage committed by the depredations of these grubs can therefore be at once recognized once it has been seen. The caterpillar only feeds upon the soft green parenchyma of the leaf, the veins and vascular tissue being left untouched. The leaves are thus "skeletonized" (see Pl. XVIII, fig. 2), and during severe attacks whole leaves will be found to be entirely treated in this way. In less severe attacks only portions of the leaves may be so treated; the larvæ, having an abundance of food, have no need to finish entirely one leaf before searching for another, as is the case when they are very numerous in the forest. In some leaves it will be found that only the epidermis of the leaf is destroyed, the leaf not being pierced completely through. This is the work of the young larva whose mandibles are not as yet sufficiently strong to cut right through the leaf parenchyma. The skeletonized leaves become brown in colour and before they fall give the forests a dull brown appearance which is in strong contrast to the surrounding green foliage of other under foliated species of trees. As Mr. Hole remarks, from a distance such forests have the appearance of having been touched by an early frost or scorched by a severe fire. In Pl. XVIII, fig. 2, which shows a portion of a leaf attacked in this way, a few small holes in the leaf tissue, where the veins of the leaf have been destroyed, will be noticed. These Mr. Hole explains as being gnawed out by the larva near to where it is feeding, so that by this means it can readily gain access to either side of the leaf. From this description of the damage done it will be readily seen that it is very easy to distinguish the work of, and therefore the presence of, Pyrausta in the forest from that of its companion *Hyblæa puera* which has been already described.

Mr. S. Carr has recently, however, found in the Rangoon plantations a caterpillar, believed to be that of the moth *Hyblæa constellata*, which is said to skeletonize the leaves in a similar manner. This is up to date the only report of this method of defoliation not being peculiar to *Pyrausta* and further careful comparison and observations are required.

From the notes on the life history given for this insect, it is obvious that it is a most dangerous pest when present in large numbers in any forest, since each successive flush of leaves is eaten off by later generations of the caterpillars.

The consensus of opinion seems to be agreed upon the point that the insect is more plentiful and increases more readily in pure teak areas than in mixed. The life history, again, shows that this is likely to be so since the moths lay their eggs on the leaves of the trees. In a pure teak area this will be a comparatively simple business, but the reverse is the case when we consider a heavy attack of the pest on scattered trees. Most, if not all, the trees will be entirely leafless and the moths will have to fly some distance, during which flight they will be subject to various kinds of predaceous animals and insects, before they will find teak foliage on which to oviposit. Observations made in the Nilambur Plantations, together with information gained there, have shown me that the insect there undoubtedly favours the large pure teak areas in contradistinction to the mixed teak forest. The trees in both young and old forest appear to be equally exposed to this defoliation. On the 26th August[1] portions of the Edakode Plantation at Nilambur, and more especially the young 1894 trees, were entirely defoliated by *Pyrausta*, the leaves still remaining on the trees being completely skeletonized and brown.

The number of insects present and the number of generations gone through appear to depend mainly upon two things—

1. A sufficiency of food material and its collection together in pure blocks.
2. On a damp humid climate, with wet, cold weather or early spring rains. In such a climate the trees will have a full crop of leaves on them in May when the first generation of larvæ make their appearance.

In the drier teak forests, when the trees are leafless at this period, the number of generations is restricted. The evidence as to the number of severe defoliating attacks in one year experienced in any one block of forest is conflicting at present, as no real records have ever been kept and *Hyblæa puera*, whose attacks have not been up to date distinguished from those of the *Pyrausta*, appears through much the same period. Evidence points, however, to at least two more or less clear complete defoliations in the year due to the *Pyrausta*, and this may be extended to three. The periods at which the most severe attacks are experienced vary. In Bombay (Kanara) October and December are given as the worst months, in the Central Provinces and Berar partial defoliations may take place in July, with a complete one in September-October. In Madras, in the Nilambur Plantations, on the other hand, the first complete defoliation takes place in April, the second in October, with probably a more or less complete one in August.

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[1] A day or two later in the preceding year (1901) I noticed heavy defoliation of young teak by *Pyrausta* in patches of forest on either side of the G. I. P. railway line while the train was running between Hoshangabad and Barkhera. The forest in the distance was completely brown. Mr. Hampson has since informed me that by the end of September in that year 90 per cent. of the trees in the Kora Range in the Seoni Division were defoliated by this insect, 80 per cent. completely so.

PROTECTION AND REMEDIES.

In the Forest.

In considering methods of protection against pests which act upon such a wholesale scale as the one under consideration, the question as to whether the remedies, advocated as practicable ones with the view of decreasing the numbers of the insect by minimizing its facilities of increasing in large numbers, are worth putting into force, is one which must be left to the consideration of the forester. In the present case I have no hesitation in advocating the formation of mixed teak forests in place of pure with a view to keeping down the abnormal increase in the numbers of this insect. As an example favouring this opinion, I would point to the Nilambur Teak Plantations, which annually suffer very seriously from the attacks of this pest and its companion *Hyblæa.* I was informed there, and my observations in August would seem to confirm the statement to some extent, that the young plantations from 1 to 15 years in age suffered the most severely. It may be that the trees being so much smaller, the attack has been the more noticeable. If this is the case, I would advise planting up the areas with a mixed forest instead of with pure young teak plants as at present, the less valuable crop to be cut out as soon as the forest has gone through about a third of the 92 years rotation fixed for it. I have no doubt that this would interfere with the great and unchecked increase at present taking place in the numbers of this insect in the plantations. If it is considered inadvisable to interfere with the present system, I would suggest that one of the annual coupes be planted up in this manner and a record kept of the attacks of the pest in it (see note on this subject under *Points in the life history,* etc.).

2. A suggestion was made by Mr. Gordon Hadfield[1] that the plantation elephants should be driven up and down the teak lines, as he noticed that the insects pupated amongst the leaves on the ground. This suggestion I consider a most excellent one as, if put into force towards the end of a heavy defoliating attack, numbers of the pupæ would be undoubtedly got rid of in this way. The best time, however, at which this method of protection should be put into force will be after the insect has hibernated in the ground for the winter months, *i.e.*, between December and April. I would suggest that during this period every plantation should be visited, if possible twice, and the elephants taken up and down the plantation lines. Mr. Hole has made a similar suggestion for the Central Provinces, proposing that pigs should be allowed into the forest for this purpose. It would undoubtedly be of great use.

3. It has been observed on more than one occasion that during severe attacks of these pests, birds, such as crows, mynas, bulbuls, *etc.*, are to be found in numbers feeding upon the larvæ, and the suggestion was made by Mr. Tireman at Nilambur that it might be feasible to introduce a large number of crows and mynas into the plantations. I think the experiment would be well worth trying, and I noticed that crows were to be had in plenty upon the beach at Calicut only some 40 odd miles away.

4. Mr. Hole has noticed that the larvæ suffer from the attacks of an ichneumon and a fungoid disease. Both of these require careful working out, and more especially the latter, as if cultures can be made it would give us perhaps the best of all weapons for combating the attack.

In the Nursery.

1. In 1901 I recommended that the teak plants in the central nursery at Poona should be sprayed with the Paris green arsenate (see p. 146, No. 1) in order to kill off *Hyblæa* and *Pyrausta larvæ.* I have since heard that this was successful and

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[1] *Vide* Report and Working Scheme of the Nilambur Teak Plantations by Mr. P. M. Lushington, Deputy Conservator of Forests, p. 45.

the treatment, which is quite simple and feasible, should be made use of in young nurseries of teak when these pests make their appearance.

2. Whilst an attack is in progress, the dried leaves in the nursery should be left *in situ* until the larvæ have pupated. They should then be swept up and burnt to kill off all the pupæ in them.

Points in the life history requiring further observation.

1. Mr. Hole's excellent series of observations made in the Central Provinces require confirmation in other parts of India, and especially the one relating to the hibernation of the larvæ in the soil during the cold-weather months. This latter may be said to be more especially important at the Nilambur plantations.

2. Observations are required as to the exact periods in the different teak forests when the worst attacks, *i.e.*, those resulting in complete defoliation, are experienced.

With the above object in view I would suggest that registers be opened showing the name and locality of the particular forest; its nature, whether pure or mixed ; climate, whether moist or dry. Then, month by month, the attacks of the Pyrausta should be entered, the defoliation being shown roughly as so much per cent. of the foliage eaten, *e.g.*, 40 per cent., 60 per cent. or complete defoliation. At the end of the year a short summary of the weather experienced, whether very dry or unusually wet, should be added.

Such registers kept up for the teak forests of the country during a period of five years would be invaluable and would enable us to understand the circumstances which lead to bad attacks of the pest, and perhaps allow us to prepare for them.

The Registers should of course distinguish between the attacks of Hyblæa and Pyrausta, separate columns being opened for mixed attacks of both.

HYPSIPYLA ROBUSTA, MOORE,[1]

THE TOON-TWIG BORER.

Plate XIX, fig. 3, *a*, *b*, *c*.

References:—Moore, Lep. Ceyl. iii, p. 365, pl. 184, figs. 4, 4*a*. (larva); Rag. Mon. Phyc. p. 139, pl. vi, fig. 12; C. & S. no. 4598; Hypsipyla pagodella, Rag. Nouv. Gen. p. 10; C. & S. no. 4566; Hmpsn. Faun. Br. Ind. Moths, iv, 89, no. 4384; Magira robusta, Steb. Inj. Ins. Ind. For. 122, pl. viii, fig. 2.

Classification:—Order, LEPIDOPTERA. Sub-Order, HETEROCERA. Family, Pyralidæ.

Trees attacked:—Cedrela Toona, Roxb. (Tun); Swietenia Mahogani, Linn. (Mahogany).

Description.

The *eggs* of this insect do not appear to have been yet described in India.

The *larva*, when young, is a reddish-yellow in colour, the segments being covered with minute black tubercles. When full grown, the colour changes to blue, the head being black and the segments of the body covered with black tubercles from which spring short stiff hairs. Length 1 inch.

Hampson describes the larva as purplish grey with a few short hairs; somites spotted with black and with a lateral series of red spots; head and dorsal patch on 2nd somite black.

Pupa is enclosed in a dense closely-fitting elongate silken cocoon, these cocoons at times being found collected together bound up in a thick felted mass of white silk (see Pl. XIX, fig. 3, *a*.) The *pupa*, when removed from the cocoon, is seen to be red in colour and ¾ inch in length.

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[1] This insect is the one which is unfortunately commonly known in India under its old name of *Magiria robusta*, Moore. This name is no longer correct.

The life history of the pest in the Changa Manga Plantation in the plains of the Punjab was worked out in 1898-99, by Mr. Coventry, a detailed account being published in the *Indian Forester*, Vol. XXV, No. 9 (1899). I have reproduced most of these excellent observations here, including some notes on a subsequent correspondence I had with the author on the subject.

The *moth* has a pearly lustre. It is brown in colour with faint black markings on the veins. It is thus described in the Fauna of British India by Hampson :—

Pale rufous-brown irrorated with black and grey. Fore wing with the costal half strongly suffused with grey; the veins all streaked with black; some olive-yellow on base of costa and median nervure, on extremity of median nervure and discocellulars; traces of a dark sinuous medial line, with a dark patch beyond it on inner margin, and of a very highly dentate oblique dark postmedial line bent outwards between veins 5 and 2. Hind wing semi-hyaline white; the costal area suffused with fuscous; the base of cilia pale rufous. Pl. VIII, fig. 3, in *Injurious Insects* shows the larva, pupa, and moth of this insect. Exp. ♂ 26-32, ♀ 28-42 millim.

Life History.

This insect, according to Mr. B. O. Coventry, passes through two generations in the year in the plains of the Punjab, and this number is not unlikely to be exceeded in the moister and warmer parts of the country. Its life history in the Punjab plains is here described.

The eggs of neither generation have yet been obtained. The larvæ first appear at the beginning of April as soon as the tún trees come into flower. They feed upon the petals, young fruits and ovules of the tree, becoming full fed about the middle of May. Mr. Coventry states that these larvæ very rarely attack the shoots of the tree and only do so when there are no flowers or fruits upon it. My own observations made in the same plantation (Changa Manga) in April 1901 showed me that the caterpillars were to be found in the shoots in some numbers on trees on which the flowers and fruits were very seriously attacked. This may have been due to the fact that the grubs were exceedingly numerous during that year. The more forward of the larvæ commence pupating about the beginning of May, and pupation takes place in two ways. Those insects that have been feeding upon the flowers and fruits march down on to the trunks of the trees and collect together in numbers beneath loose flakes of bark and pupate in this position. Thick felt-like masses of a silken material containing numerous pupæ, enclosed in the silken cocoons, embedded in them are thus obtained (see Pl. XIX, fig. 1, *a*). The larva gives out a silken thread as it moves about, and the inflorescences, fruits, and branches and bark of the trunk thus become covered with dense masses of silken threads in which excreta, partially-eaten petals and fruits become entangled. In a severe attack the larvæ are to be found in swarms upon the bark of the trees during the first part of May searching for pupating places. Once they have pupated, however, they are no longer to be seen on the outside, and it is only by stripping off the flakes of bark that the pupæ will become visible. Pl. XIX, fig. 3, *a*, shows a mass of these pupæ on the underside of a piece of bark. The larvæ which tunnel into the stem change into the chrysalis state in the burrows they make in the terminal shoots. They also spin a silken cocoon before pupation. Fig. 3, *b*, in the plate shows a hollowed-out twig with the packed excreta of the larva exposed at the top; 3, *c*, a cocoon *in situ* in a hollowed-out branch.

The pupal stage lasts about a week or ten days, the first moths appearing at the end of the first week in May and continuing to be found on the wing throughout June and July. Mr. Coventry in his note considers that these moths are all those of the first generation, and they are taken to be such here. The following are suggestions for further observations on this point:—

1. Is it not possible, since moths are to be found on the wing during some 12 weeks, that there may be more than one or even a series of generations of the insect overlapping one another between April and the end of July?
2. Or, do the moths from those larvæ which tunnel into the shoots take longer to develop and issue than in the case of those coming from the larvæ which feed upon the flowers and fruits? It is not at all improbable that the caterpillars feeding upon the succulent terminal twigs take longer to mature than do their comrades on the fruits.

It seems hardly probable that the insect should hurry through its pupal or resting stage (during which period it is perfectly protected against birds, etc.) in a few days only to spend some 6 to 8 weeks on the wing.

The larvæ of the second generation appear at the beginning of August. They confine themselves entirely to tunnelling into the young terminal twigs of the tree, since there are no longer either flowers or fruits to attack. At the end of September they become full-fed. The pupal stage lasts through the first half of October, the moths emerging about the middle of the month.

This is as far as the life history has been carried. Mr. Coventry suggests with some probability that, as the tún tree loses its leaves at the beginning of November in the plains of the Punjab, the eggs are not unlikely to be laid on the stems of the trees, spending the winter in this condition. I consider with him that this is more likely to be the case than that the ♀ moths live through the cold Punjab winter and lay their eggs in the spring.

In feeding upon the inflorescences and fruits the petals of the flowers are eaten by the caterpillars and the young fruits are entirely consumed. Older fruits, however, whose outside has become harder, are burrowed into and the contents devoured, leaving nothing but an empty shell with a round hole in it. Having devoured the contents of a fruit, the larvæ leave it and proceed to attack the next in the same way, the inflorescences and bunches of fruits thus becoming a tangled mass of white silk.

In attacking the tún shoots, the larva almost invariably tunnels in at the axil of a leaf or of a smaller offshoot, the young bud being eaten. The entrance hole can be recognized by the gummy exudation which takes place from it. Once inside the shoot it mines up the pith, destroying all the interior, the attack causing the death of the branch, which withers up.

As I have already mentioned, the life history will vary slightly with the climate and elevation of the localities at which the tree is growing (vide *Injurious Insects*, p. 123).

Locality from where reported.

This insect is widely distributed in India, it having been reported from the Punjab (Changa Manga Plantation), United

Provinces (Lucknow and Dehra Dun), Bengal (the Duars) and Madras (Nilambur). I have found it common in Bengal whereever the tree exists.

Hampson gives Simla, Dharmsala, Sikhim, Ceylon as the distribution.

Relations to the Forest.

Both young and old tún trees and also coppice shoots are most seriously injured by this pest. In the case of old trees, the shape and shade density of the tree is greatly interfered with as year after year the young twigs die down under the attack. This is very apparent in tún avenues. In many parts of Bengal, and more especially on several tea gardens where the tree has been planted in avenues to shelter the roads, I have noticed that the trees, under the persistent attacks of this borer, have grown up straggly and rugged in growth, the object for which they were planted being greatly impaired by the insect. Further, the branches being weakened appear to suffer severely in storms, a tún avenue being generally littered with branch wood after high winds. I do not consider that the tree planted pure is to be recommended as an avenue one.

In addition to the small branches, the seed crop suffers severely from the pest, and in bad years the entire crop is sacrificed, the bunches of fruits containing no seeds, but consisting simply of empty shells each with a round hole on one side of it.

With young saplings and coppice shoots the attack is even more serious, since terminal and side shoots over a foot in length turn brown and wither, their interiors being entirely eaten out by the burrowing larvæ The trees thus become forked and much branched at an early age, and the height growth is interfered with and short ill-shaped and ill-grown trees are the result.

Protection and Remedies.

It is generally difficult to prescribe remedies for insects whose whole life history is still unknown, and this one forms no exception to the rule. We know when and where to find larvæ, pupæ, and adults of both generations, but where the eggs are deposited is still unknown. It is necessary to find out where these are laid, as it is in the quiescent or cold-weather stage that such insects are usually most easily attacked.

Mr. Coventry in his note writes as follows:—

"*Remedy.*—On a large scale little can be done against this pest; but where young plantations exist, much good can be done by cutting back the attacked shoots carefully above a bud, at about the middle of September or just before the larvæ pupate. The shoots containing the larvæ should be burnt. The bud below the cut will develop and produce a shoot which will replace the old terminal shoot, and it will have the whole of April, May, June, and July in which to put on growth before it is likely to be again attacked . . . . During the first generation a great many larvæ might be destroyed by collecting them from trunks of trees about the beginning of May before they pupate, or pupæ could be collected and destroyed by peeling off the pieces of bark containing them and burning them. In any case, if timber trees are required, it will be necessary to prune them, otherwise the boles are forked very low down."

During severe attacks it would also be advisable to collect and burn as many of the infested fruits as possible. Small boys could be put on to this work in plantations.

The above remedies would both undoubtedly do good, but as the life history shows, they would have to be done quickly, and would therefore in large plantations prove costly.

It is an axiom in combating insect attacks that the longest stage in their life history should be the one during which methods of destroying them are undertaken. In this case the longest stage is undoubtedly the winter one. If the stage proves to be the egg one, it should prove comparatively simple to introduce some method of getting rid of them, since there will be some five months during which the operations can be carried out. If the eggs are laid upon young growth, pruning will have the additional advantage, as Mr. Coventry suggests, of removing all badly-shaped saplings and obtaining in their place straight trees.

Points in the life history requiring further observation.

1. Where the moths found on the wing during May June, and July lay their eggs.
2. Is there more than one generation between April and the end of July? If so, how many?
3. The number of generations in the year in the warmer and moister parts of India.
4. Where the October moth lays her eggs, and when? Is the winter passed through in the egg stage?

A further note on the life history of
MONOPHLEBUS STEBBINGI,
GREEN.
THE SÂL TREE WHITE SCALE.

Plate XIX, fig. 4 *a*, *b*, *c*, *d*, *e*, *f*.

(See pp. 135—141 in No. 1.)

Tree attacked :—*Shorea robusta* (Sâl).

Description.

Egg.—The eggs are laid by the female in a fine-meshed thin cottony sac or bag as shown in Pl. XIX, fig. 4, *a*. The eggs are dry, shining, and pink in colour and separate, not being joined together by any siccable substance. They are oval-elliptical in shape and $\frac{1}{24}$th inch in length (fig. 4, *b*).

♂.—*pupa ?*.—I have found some small light-brown empty pupal cases which I take to be the pupal cases of the ♂ insect. They are $\frac{1}{6}$th inch in length with an elliptical opening at one end by which the insect had crawled out. Pl. XIX, fig. 4, *c*, shows this pupa case and 4, *d*, a drawing of the mature winged ♂ insect which issues from it.

Life History.

Egg-laying.—The ♀ scales were found laying eggs towards the end of April and beginning of May. Before the eggs are laid, the under-segments of the body are seen to be developing a white woolly hair. This increases in amount, especially towards the anal extremity, and within this white woolly mass the eggs are laid. At first this white cottony material is quite short, and, looked at from the dorsal surface of the insect, is seen to only project a little way from the tip of the abdomen. It, however, soon increases in amount until the insect appears to have a small wad of pulled out cotton wool attached to its abdominal segments and protruding out all round in a cloud from the three ventral posterior segments of its abdomen. The eggs, as stated above, are laid within this material, from 400 to 450 or even more being laid by one scale.

Present observations show that, when intent on egg-laying, the female scale leaves the part of the tree on which she has been feeding and usually searches out some nook or cranny beneath the rough bark or a sheltered spot beneath stones, refuse, wood, etc., on the ground, and conceals herself before laying her eggs. After the eggs in the cottony sac have been extruded from the body little but the skin remains, the insect dies, and the dried shrivelled skin remains as a partial covering to the eggs. Egg-laying would appear to last from a fortnight to three weeks, after which period both the large white ♀ scale and the winged ♂ almost entirely disappear from the forest, the latter entirely. What I take to be the ♂ pupal cases were discovered on a sâl tree felled in January 1901; they were on the outside of the bark, where it was almost in contact with the ground. Amidst a mass of cottony material mixed up with dried leaves, twigs, etc., the following were found:—

(*a*) Dead ♀ scales about ¼″ in length and immature.

(*b*) Immature and mature dead winged ♂ insects and portions of their wings, bodies, etc.

(*c*) Also amongst the cottony material small, dried, dark orange larvæ were found of the same shape as the ♀ scale, ⅛th to ⅙th″ in length. These may have been immature ♀'s or they may have been male larvæ.

(*d*) Small, light-brown pupal cases of ♂ (?) insect, ⅙th″ long, with an opening at the top by which the insect had crawled out.

(*e*) What looked like shrivelled pink egg skins.

In one or two instances I found portions of ♂ insects half protruding from the light brown cases, and this latter fact leads me to conclude that the winged males come out as such from these shells. Further, it may be that the pink shrivelled egg cases were those of the eggs of last year from which the males of this year had developed, and that the males hibernate through the rains and portion of the winter in the egg stage.

Beneath this tree, under the rough flakes of bark, a number of newly-deposited egg clusters were also found.

I have not yet found the insect which develops from these, or from portions of these, egg clusters, *i.e.*, the insect which forms the second stage (if there is one) in the life history of this monophlebus.

I have said that the conspicuous white female scales disappear from the forests about the beginning or middle of May, the exact time depending upon the nature of the weather experienced during the winter. Mr. Milward has noticed, however, that it is generally possible to find a few specimens right on into September. This year, when the attack was practically over, on May 7th and later dates, I found in several places some young scales, canary yellow to brown in colour and from $\frac{1}{12}$th to $\frac{1}{8}$th″ in length, in fact in the stage and age of those usually found in February. They were clustered thickly on the new shoots of some sâl trees and on the top shoots of some sâl saplings and sâl and *koura* coppice.

As compared with the previous year, the scale matured at a much earlier date during 1902, the insect being at least a month earlier in all its stages of development. This was undoubtedly due to the fact that the winter was a very dry and rainless one, and consequently the young scales did not perish in the large numbers which a rigorous winter must usually kill off. Until its third moult, it increased in size apparently unchecked, and was found throughout the Dun and Saharanpur forests in enormous numbers. By the time it is ready to undergo its third moult, it being then about half-grown, it has left the leaves and small twigs and descended to the larger cortex-covered branches, and throughout the attacked areas these branches were encircled with long rows of the white cast papery skins of the third moult, which remained gummed to the branches by the thick sugary secretion given out by the insects. These rows corresponded to the position the insects take in feeding, collecting in clusters all down the stems. Pl. XIX, fig. 4, *e*, shows a number of these cast skins attached to a branch. It was at this stage that a check came this year (1902) to the attack. The enormous increase of the scale led to a similar increase of a coccinellid beetle which feeds upon the monophlebus in both its larval and imago stages. The life history of this insect (see page 326) corresponds with that of the monophlebus in that the lady-bird reaches its imago and egg-laying stage at the same time that the sâl tree white scale begins egg-laying. An examination of various forests in April and May showed that enormous numbers of the scales had been killed off by the larvæ and adults of the coccinellid. These operations were easily discernible. As they simply sucked the scales dry, the dead shrivelled skins were to be found attached to leaves, branches, and bark of the trees or on stones, dead leaves, fallen logs, and refuse on the ground beneath. Badly infested forests were full of the dead shrivelled skins of the victims of the beetle. Leaves and branches, etc., were stained with yellow blotches of the soft body contents of the coccid. I considered that it was probable that at least 50 per cent. of the scales were killed off by the beetle between March and May, and the estimate is in all probability a low one.

Figure 4, *f*, in the plate shows the way the mature female scales collect together on the stem when feeding.

Distribution.

As regards distribution, the scale may be said to have been almost general throughout the Dehra Dun (being present in Tirsal forest, where it had not been previously noticed, and also in the Moti Chur forests and in Thano) and Saharanpur Divisions. It was numerous in the Kalesar forest of the Simla Division until decimated by the coccinellid and equally plentiful in the small outlying Dhawala forest (Saharanpur Division) on the opposite side of the Jumna.

It was also present in the sâl forests to the east of the Ganges, though I am not aware in what abundance.

Relations to the Forest.

There can be no doubt that this insect, owing to the capabilities it possesses of increasing rapidly in enormous numbers, must be looked upon as one of the most serious pests the sâl areas of the Siwaliks have to meet. The attack of 1902 was colossal in its magnitude, and both young and old growth must have suffered severely, both wood increment and natural regeneration being interfered with.

The attack of the year has brought several features in the life history of the pest into startling prominence:—

(1) That a dry winter greatly aids the scale by permitting a far greater number of young larvæ to reach maturity than is apparently the case in normal seasons.

(2) That the monophlebus has a powerful enemy in the predaceous coccinellid beetle, an enemy against whose attacks it is entirely unable to defend itself, except in one particular way, *i.e.*, by laying an enormous number of eggs so as to allow for a heavy mortality amongst its offspring.

(3) That even in the event of a heavy attack by the coccinellid beetle, the scale is enabled to grow to half-size before any appreciable difference in its numbers becomes apparent from the work of the beetle.

Protection.

The discovery of the coccinellid beetle has given one of the means by which this scale can be most effectively combated, and it has now become imperative that the former's life history should be fully worked out, and further observations on this head are required (see p. 330).

Points in the life history requiring further observation.

1. When the large number of eggs laid in the cottony sac by the mature ♀ at the latter part of April and first part of May develop?
2. What stage of the insect arises from these eggs? Is there a second stage in the life history passed through in the rains, and is this a sub-cortical one?

3. Where the ♂ larva lives and feeds. The observations on the life history of the ♂, as far as at present recorded, require corroboration.

Infestations accompanying Monophlebus Stebbingi.

(1) FUNGUS GROWTH.

It has been stated that a copious sugary secretion is given out by the scales, which coats leaves, twigs, and branches of the trees, giving them a black and burnished appearance. In this sugary secretion a black fungus develops and doubtless helps further to close up the stomata and pores of the part of the tree it infests. Dr. Butler, Cryptogamic Botanist to the Government of India, informs me that this fungus belongs to the genus *Capnodium* which is almost always associated with scale insects. The Capnodium was present in three imperfect forms—

(*a*) *Cladosporium Fumago*, Fr. and Lk.
(*b*) *Trifosporium sp.*
(*c*) *Coniothecium sp.*

the three being conidial stages in the various species of *Capnodium.*

(2) FORMIOIDÆ (ANTS).

Observation has shown that ants infest the trees upon which the monophlebus is feeding and suck the sugary secretion emitted by the latter. These ants may be observed marching up and down the trees or waiting just beneath a scale insect, and, as it emits a drop of the clear sugary excretion, they suck it up. The ants taken were submitted to Mr. Wroughton, Inspector General of Forests, and he determined them as belonging to two genera :—

(1) *Polyrhachis*, probably *P. simplex* (Mayr) (=*spinigera*, Mayr). This ant forms a nest in the form of a silk bag fitted into a hole in the ground beneath large stones.

(2) A *Camponotus* belonging to the larger group *maculatus* and probably *compressus.*

A predaceous insect enemy of Monophlebus Stebbingi.

COCCINELLA SP.

THE SÂL TREE WHITE SCALE LADY-BIRD BEETLE.

Plate XIX, fig. 5, *a*, *b*, *c*, *d*.

Reference:—Provisionally named *Coccinella* sp., new to the Indian Museum.

Classification:—Order, COLEOPTERA. Family, Coccinellidæ.

Predaceous upon *Monophlebus Stebbingi*, Green.

Description.

Larva.—When young the larva is black in colour with 3 pairs of stout legs on its thoracic segments. During its first two moults it appears to retain this colour and is longish and narrow with a well-developed head and mouth parts. As it gets older it becomes more oval and is then white and black or reddish with white markings or a greyish purple in colour. It will often be found to be covered with a certain amount of the white powdery substance which covers the scale insect *Monophlebus stebbingi* upon which it feeds. The young larva has a number of tubercles on its dorsal surface. When full-grown the larva is ⅛ inch long and has a well-developed head which is narrower than the first ten segments of the body which follow. Of these latter the middle ones are the broadest the grub tapering to each end. On each of these ten segments there are four dorsal tubercles, two on each side, so that the larva has four rows of tubercles down its dorsal surface. The last two segments make up the dark reddish-black coloured pad-like apparatus which terminates the body, the end of which forms a kind of sucker, which is very adhesive and enables the larva to cling to the smoothest bark by means of it. It uses it during feeding and also for fixing itself to leaves, twigs, or rough bark before changing to the pupal stage. The arrangement of its segments make its body extremely pliable, and it can roll itself up almost into a ball. In addition to the four rows of tubercles the segments are fringed on either side by projecting teeth resembling a saw-edge, giving the insect a serrate edge all round. The ventral surface has the same colour as the dorsal, but is smooth and has no tubercles. Just before pupating the larva often changes from the white and black or greyish purple colour to a brick red. Pl. XIX, fig. 5, a, shows a dorsal and side view of this grub.

Pupa.—When pupating the grub attaches itself to the upper or under-surface of a leaf or to a twig or rough bark by means of the adhesive pad at the posterior end of its body, projecting at an angle from the point of attachment and assuming a curved position, its dorsal surface being convex and ventral one concave. It has the appearance of standing up on its tail. (See fig. 4, d (1). The larva remains in this position for about 24 hours and then the outer skin splits down dorsally from the anterior end to the end of the tenth segment and the skin gets drawn or shrivels back on either side and the bright red, almost spherical, pupa is disclosed. The pupa nestling in the surrounding purple and white speckled old larval skin looks not unlike a small wild strawberry fruit sessile upon the leaves. In the crimson pupa the two small black eyes of the future beetle and developing wings and dorsal abdominal ridges of the segments can be seen under the bright orange red skin The anterior or head end of the beetle faces away from the point of attachment and is at the other end of the pupa. The colour varies from bright to dull red, crimson or orange red. Size about ¼ inch. In the plate fig. 4, b, shows a pupa on a leaf and d (2) on a branch.

Beetle.—When the beetle is ready to issue the pupal skin splits down dorsally and ventrally at its anterior end and the beetle crawls out. It is a small oval insect and is at this period bright orange red in colour and thickly covered with a fine white down. The elytra and thorax soon harden, lose the white down to a great extent and are then a darker red in colour. The head is prominent with black prominent eyes, and short antennæ ending in a small club. There is a black spot at the base of the prothorax. The elytra are dark red and are six-spotted. Posteriorly on each there is a crescent-shaped black patch, the convex side being outwards and the patch being set at an angle pointing upwards. Above these there are two smaller spots situated on each wing case, the outer ones being placed slightly anteriorly to the median ones and being slightly smaller. Length ¼ inch. The ♀ beetle darkens in colour after pairing, the elytra becoming almost black and the spots scarcely visible. Pl. XIX, fig. 4, c, shows a dorsal view of this lady-bird beetle.

Life History.

This insect was found in all its stages of larva, pupa and imago in the Siwalik sâl forests in the middle of April 1902. Probably it is usually a few weeks later in normal years as the year in question was particularly favourable to insect development. The exact length of time spent in the larval stage has not yet been definitely observed, but it is probable that at least 3—4 weeks are passed in this state. In the year in question the larvæ commenced pupating about the end of March. Eight and nine days is the length of time spent in the pupal stage, larvæ which changed to this state on 16th April, issuing on 24th and 25th of the month. Numerous others were bred out on other dates, and this period appears fairly constant. The beetle appears to pass some days, perhaps as much as a fortnight, in this stage before pairing. The ♂ insect dies within 24 hours of fertilizing the female. The latter then commences egg-laying and apparently conceals herself to perform this operation. The eggs have not yet been found, but beetles were discovered near the cottony masses in which the monophlebus eggs are laid beneath rough bark of fallen trees and they may lay their eggs in the same places as the scale. The insect in both its larval and beetle forms feeds upon and destroys the scale insect *Monophlebus stebbingi.* The larva is a very active grub running over the leaves, twigs and bark of the tree at a great pace in search of its prey. During this portion of its existence the insect is not gregarious, the grubs never being found together. The larva is a very voracious feeder and attacks and feeds upon the large soft-bodied white scales with the greatest avidity. Its method of feeding is as follows: The moment the grub sees a scale it goes straight for it and fixes its mouth parts in the soft skin of the coccid, often on the ventral surface between the first and second pair of legs and a little to one side. At the same moment it attaches itself to the twig by means of the adhesive pad at the end of its body. The scale at first makes no movement, but after a minute or two it commences to move its legs and antennæ about, at first lazily as is its habit when walking, but later on more vigorously As it begins to do this a bright canary yellow stream of liquid material pours down from the scale on to the twig. This exudation from the wound continues for about 3-4 minutes after which it stops, the rest of the material going into the coccinellid larva who has now got his mouth parts firmly fixed into the coccid. The latter makes vigorous attempts to get away and being so much larger than its enemy, often even as much as thrice its size, it at times stretches out the lady-bird larva to its full length, the segments under the tension becoming considerably elongated. The latter, however, keeps its position on the twig by means of its sucker pad with the greatest ease. Practically only its mouth, first pair of legs and adhesive pad are used in its feeding operations, the other two pairs of legs being held backwards almost against the side of the body. Under the sucking process the formerly fat white juicy scale insect shrinks to a shrivelled, wizened, dried up mass of skin. The larva's mouth consists of a tube ending in a swollen knob where it joins the head, which is greenish yellow in colour. This is probably in the nature of a sucker as well since it exerts considerable leverage upon the scale. Larvæ watched have spent between 8 and 9 hours clinging to and feeding upon one scale, at the end but a shrivelled black skin remaining. The vitality of the coccid is very great since at the end of 6 or 7 hours of this continued sucking it is still alive slowly moving its legs or antennæ.

When about to pupate the larvæ would seem to become gregarious as the pupæ are often found in numbers close together on the upper or under side of the leaves or twigs. This may have been due to the enormous number of the insects present in the forests in April, but the gregarious collections of pupæ were too marked to have been entirely due to accident. The beetles are very gregarious. During the heat of the day, when not feeding, they are to be found in large numbers collected close together on the underside of leaves—Sâl leaves, Bauhinia, and other large leaves being the ones chiefly made use of. The beetles also feed upon the white female scales, attacking them in the same way as their larvæ anywhere on the upper or under surface of the body. They pierce through the skin and a drop or two of the yellow liquid comes out, but never more. They do not kill the scale outright as they appear to be full fed in half an hour by which time they have absorbed but a small quantity of the scale's body substance. Whilst feeding, the scale either continues to remain with its beak buried in the tissues of the sâl twig or it may move about with the beetle attached to it, but it does not appear to be inconvenienced to any great extent and only shows signs of pain when the beetle first pierces through its skin. The scales are evidently killed off in time by constant tapping by different beetles. Scales so tapped show numbers of small white and yellow spots, the places where the beetles have pierced them. They also are much shrivelled, are dirty brown or whitey black in colour and move slowly.

The ♀ beetle appears to commence egg-laying at the time this operation is being performed by its host, the sâl tree white scale.

Locality from where reported.

This coccinellid was found plentifully during 1902 in the Siwalik sâl forests of the United Provinces.

Relations to the Forest.

During the last few years the scale insect *M. stebbingi* has appeared in large and increasing numbers and has proved a serious pest in the Siwalik sâl forests. During the present year, owing perhaps to a very dry and mild winter, the attack assumed large dimensions, the young coccids being in enormous numbers almost throughout the entire Siwalik and some adjacent sâl areas. When about half-grown the scales were attacked by the larvæ of this coccinellid, which owing to the large increase in their food-supply and to the favourable winter, had themselves increased in incredible numbers. By the middle of April the forests were full of larvæ, pupæ and lady-bird beetles; the former were to be seen running agilely over the trees in quest of their prey whilst the two latter were to be found collected in masses on the leaves. The writer made a tour round the whole of the Siwalik forests and everywhere this insect was swarming, the leaves being weighed down by the red masses of the beetles clinging during the heat of the day to their under surfaces. As a result of this great increase of its enemy the scale was decimated and everywhere, once the state of affairs taking place was understood, the sucked out and dry shrivelled skins of the scales could be found plentifully. The numerous empty white skins of the third moult of the ♀ scales proved that they had reached this stage in their life history in safety and in enormous numbers—numbers which were no longer present in the forest in the middle of April though it must be allowed that the insect was still plentiful. There is no doubt that it is the coccinellid larva that is the chief decimating agent, but it is probable that the attacks of the beetle, taking place as they do when the ♀ scale has reached maturity and is pairing, so weaken it as to have an injurious effect upon the eggs laid. This point requires further observation.

As is to be expected from the above it was particularly noticeable that in those forests where the beetle was swarming in the largest numbers the living scales were by no means numerous, whilst dried, dead, shrivelled skins were to be found on the rough bark or in its interstices, and littering the ground amongst dead leaves, stones and other refuse.

Protection.

This coccinellid has proved itself a valuable insect in the forest. It would not seem to require much protection in either its larval or beetle stages. It is probable, however, that its pupal stage, which is so easily discernible, must suffer from attacks of birds unless its colouring and peculiar shape serve to protect it from these. It is necessary, however, that we should know exactly where the insect lays its eggs, as it would not improbably be possible to collect these and place them in safety till the following year, should it prove that the beetle has but one life cycle in the year. It is more than probable that the insect could be used as a cure for other serious attacks of scales and aphids, and it would therefore be of great utility to collect and preserve the eggs.

Points in the life history requiring further observation.

1. Where the eggs are laid.
2. Is there more than one life cycle in the year?
3. Does the coccinellid feed upon other insects besides the sāl tree white scale?

PARASITES AND ENEMIES OF COCCINELLA SP.

1. Parasite on the Larva.

A parasite infests the larva. Numerous larvæ were observed in the first stage of pupation attached to the twigs or leaves. A close examination showed a number of minute holes on the external surface of the skin, as many as five or more in number. These were evidently the exit holes of hymenopterous or dipterous parasites, the whole of the inside of the larva having been eaten out. It is evident that the larva of the parasite allows the coccinellid grub to reach maturity and pupate before finally killing it, so it is probable that the former will have destroyed a good many scales before it is killed off itself. There is no doubt, however, that a parasite of this kind must do a great deal towards keeping the predaceous lady-bird beetle in check and reducing its numbers.

2. Enemy of the Pupa.

I have observed that the pupa of the coccinellid is killed off by the larva of its own species. Larvæ were found with their three pairs of legs round the red pupal case and their jaws buried in the skin, which they had pierced and from which they were sucking out the entire contents. Examination showed me numbers of pupæ treated in this way, all of them having a round hole about their centres. Grubs subsequently kept had no hesitation in feeding upon the pupæ. It may be that there was a shortness in the supply of the *Monophlebus* scale or that the larva is a generally predaceous one. I think the reason may probably be the former as it was only the later and last of the larvæ that were seen acting in this way, but this point requires further careful observation.

MONOPHLEBUS STEBBINGI, VAR. MANGIFERÆ, GREEN.

Reference :—Green in litt.

Classification :—Order, HEMIPTERA. Family, Coccidæ. Sub-Family, Monophlebinæ.

Tree attacked :—***Mangifera indica*** **(Mango).**

Description.

This insect is very similar in appearance to *Monophlebus stebbingi*, Green (see No. 1 of these notes, pp. 135, 136). The females are identical, and Mr. Green states that the males only differ in the presence of a very small fourth tassel on each side. Fig. 4, d, in Pl. XIX shows the appearance of the ♂ of this scale, and fig. 6 shows the ♀.

Life History.

This scale was first noticed upon the mango trees at the beginning of March and disappeared about the middle of May. The females (described as large white flat insects) were to be seen walking about on the ground and crawling up the trees. It is probable that they must have been present in the plantation in January and February, if not earlier, but being then small and yellow or brown in colour they were not noticed clustered first round the mid-ribs of the leaves and then on the young twigs. A careful inspection of the trees at this period will probably disclose numbers of the insects. The mature females (the white insects) are found clustering round the twigs below the fruit where they suck out the sap of the twig causing the fruit to fall off. As in the case of the white sâl scale, the empty papery skins of the different moults are found sticking to the bark of the twigs, etc., fixed to them by the sugary secretion excreted by the ♀ scale. (*cf.* Pl. XIX, fig. 4, e.)

The winged males are found on the leaves. They are said to be present only where the mango trees live in very moist soil. This statement is not understood and further observation is required upon this point.

There is apparently some confusion between the damage done by this insect and that of 'a flying insect' called locally in the Punjab 'Tela' which is said to secrete a gum on the flower heads of the mango thus preventing fertilisation. This insect is said to appear earlier than the scale. The 'Tela' insect may be plentiful in the gardens before the scale is noticed, and may do injury to the trees, but I think it is more than probable that the gum which prevents the fertilisation of the flower heads is the excretion of the young larval scales, which would be very plentiful on the trees at this period and would excrete large quantities of sugary secretion (see p. 137 in No. 1).

Locality from where reported.

This insect was reported from the Shalamar mango garden in the Punjab in the spring of 1902, by Mr. F. Beadon Bryant, Conservator of Forests, Punjab. It was said to have attacked the garden in the previous year and to have diminished the outturn of fruit of the trees.

A *Monophlebus* was also reported by the Manager of the Public Gardens in Bareilly in April. It was said to be attacking the mango trees there. Mr. Green informs me that this is likely to prove identical with *M. stebbingi* var. *mangiferæ*, Green.

Protection.

The Conservator in forwarding the insect asked whether 'grease rings' would be useful in getting rid of the pest. From what is known of the life history of its close relation I am of opinion that a good deal might be done to reduce the numbers of the insect by these means. A thick band of the material, about 18 inches deep, should be painted on the trees at about 5 feet from the ground towards the middle to the end of March, depending upon whether the winter has been a dry and favourable one (when the insect will develop quicker) or cold and wet. These bands should be kept sticky until the middle of May. The insects at all times walk about a great deal, but more especially after fertilisation when they cease feeding and, leaving the upper parts of the tree, walk down the trunk to seek places where they can conceal themselves to lay their eggs. The grease bands would thus catch and kill them at this period and prevent egg-laying. When the attack is over the bands should be carefully scraped, and the scrapings burnt to kill any eggs which may have been laid on them before the ♀ died.

The grease bands should be composed of a mixture of tar and glue mixed in such proportions as to ensure a sticky band.

A second plan for getting rid of the scale will be by the importation of the coccid lady-bird beetle (*Coccinella* sp.) which is predaceous upon the allied scale *M. stebbingi* in the Siwalik forests (see p. 326 of this number). This should be quite feasible and will be attempted at the next attack.

Points in the life history requiring further observation.

1. When the scale first makes its appearance on the mango trees.
2. Whether there is a heavy excretion of sugary liquid in January and February.
3. Whether any lady-bird beetles accompany the scale insect. (Their larvæ would be small fast-running brown or black grubs.)
4. Does the scale make its appearance at any other time of the year?
5. The amount of injury done to the trees by this insect.

G. I. C. P. O.—No. 3079 R. & A.—9-3-1903—1,000—J. W. DeB.

PLATE VII.

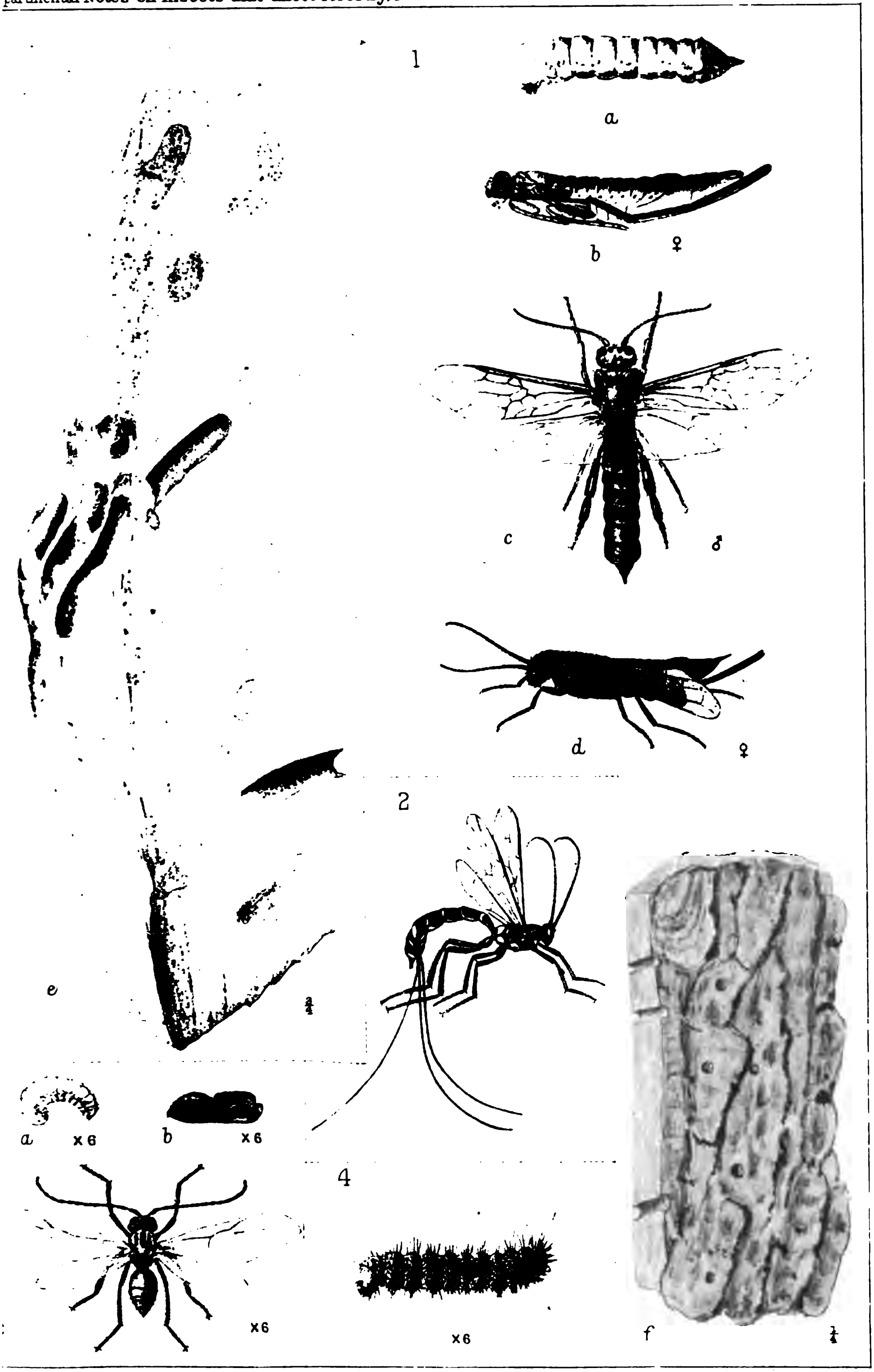
FIG. 1. SIREX SP. *a.* Full-grown larva; *b.* ♀ pupa; *c.* imago, ♂; *d.* imago, ♀; *e.* A piece of spruce-wood showing vertical and horizontal sections of the larval tunnels; *f.* Piece of bark showing exit holes (the larger ones) and sections of the galleries (the larger ones) made by the adults on escaping from the tree.

„ 2. THALESSA or RHYSSA SP. Side view of imago, ♀.

„ 3. CALLIRHYTIS SEMICARPIFOLIÆ, Cameron. *a.* Full-grown larva. *b.* Nearly mature pupa. *c.* imago

„ 4. *Heterocerous larva.* Found in company with *C. semicarpifoliæ.* Side view.

☞ NOTE.—When the figures are not drawn actual size, the actual size is represented either by a hair line or by a figure showing the number of times it has been enlarged.



Mondul, del.

Photogravure, Survey of India Offices, Calcutta, January 1903.

1. SIREX SP.
2. THALESSA OR RHYSSA SP.
3. CALLIRHYTIS SEMICARPIFOLIAE, CAMERON.
4. HETEROCEROUS LARVA.

PLATE VIII.

Fig. 1. Dinoderus pilifrons, Lesne. *a, a.* Dorsal and side view of beetle; *b.* Piece of bamboo riddled by larval and beetle tunnels.

„ 2. Bostrichus parallelus, Lesne. Dorsal and side view of beetle.

„ 3. Platyros sp. Dorsal and side views of the ♂ and ♀ beetles.

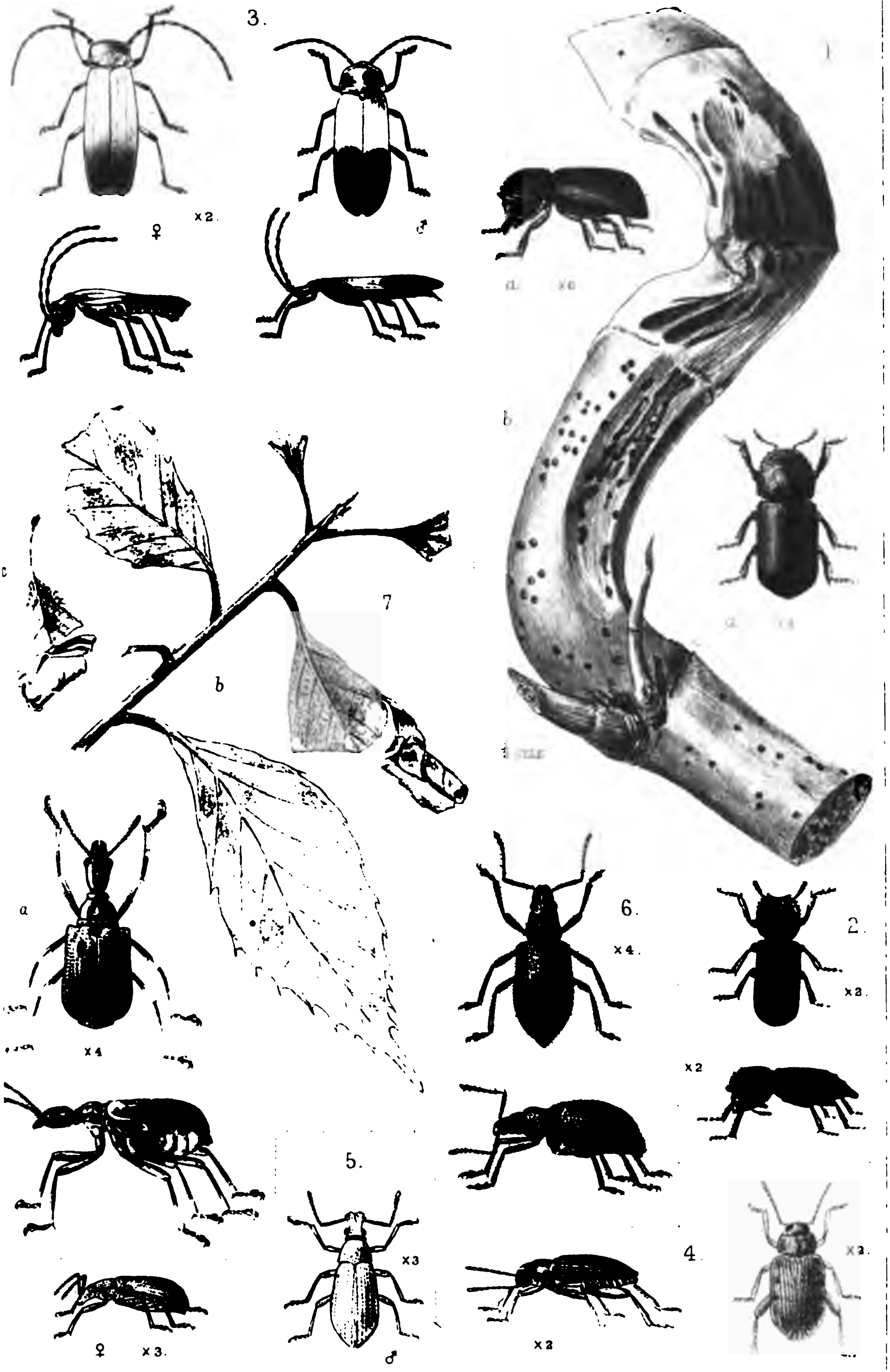
„ 4. Halticides. Dorsal and side view of the beetle.

„ 5. Myllocerus acaciæ, MS. Dorsal view of the ♂ beetle and side view of the ♀ beetle.

„ 6. Cyphicerus sp. Dorsal and side view of the beetle.

„ 7. Apoderus incana MS. *a.* Dorsal and side view of the ♀ beetle; *b.* Portion of a branch of *Quercus incana*, the leaves of which have been attacked by *Apoderus incana.*—[From a drawing by the Author]; *c.* A rolled-up leaf of *Quercus incana* containing an egg showing the method of rolling adopted by this beetle.

[From a drawing by the Author.]



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Photogravure, Survey of India Offices, Calcutta, January 1903.

1. DINODERUS PILIFRONS, LESNE.
2. BOSTRICHUS PARALLELUS, LESNE.
3. PLATEROS SP.
4. HALTICIDES.
5. MYLLOCERUS ACACIAE, MS.
6. CYPHICERUS SP.
7. APODERUS INCANA, MS.

PLATE IX.

CYRTOTRACHELUS LONGIPES—

a. Eggs.

b. Larva (side view).

c. Beetle, ♂.

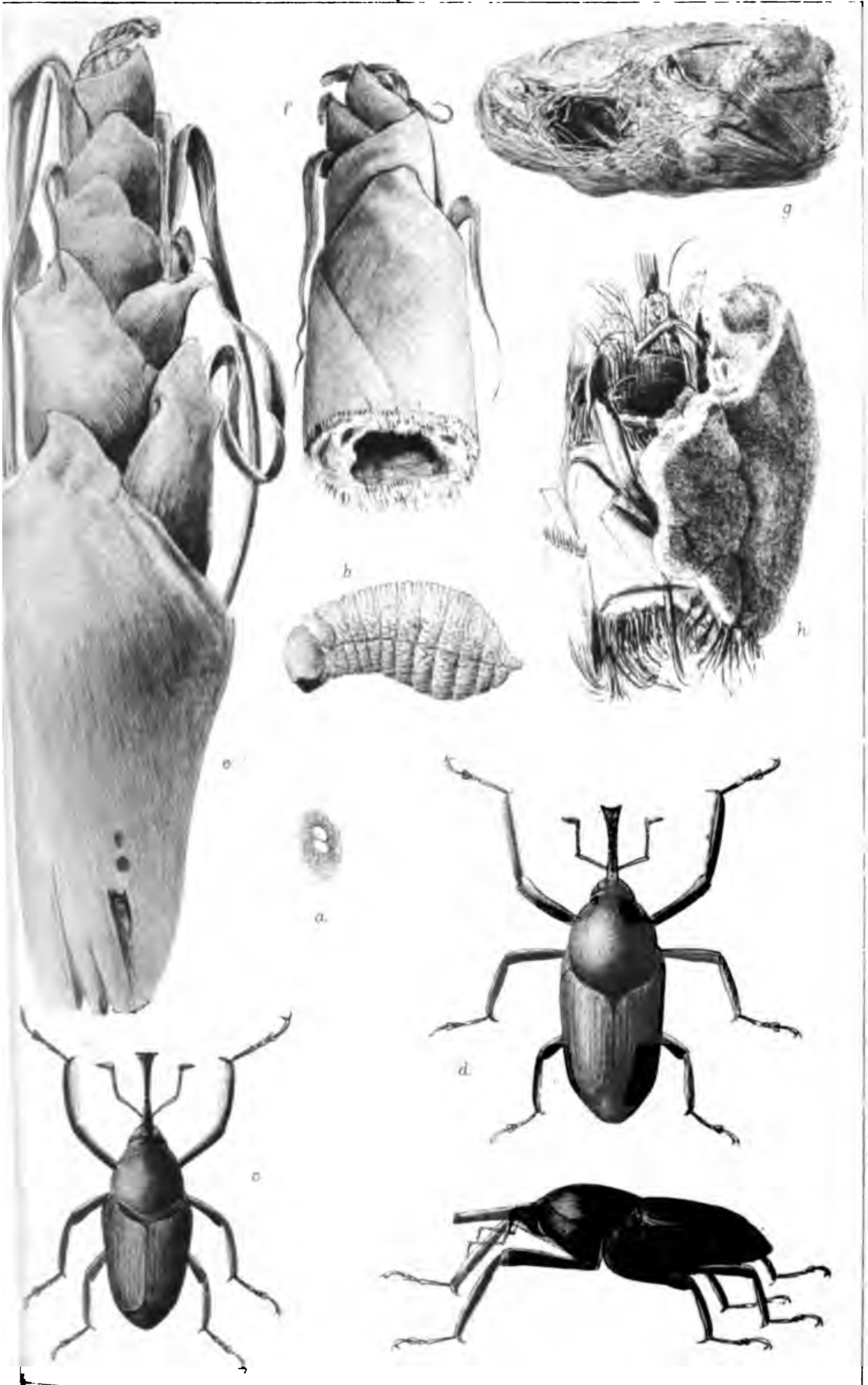
d. Beetle, ♀ (dorsal and side view).

e. Young bamboo shoot in which eggs are laid by the female.

f. Top of bamboo shoot cut off by full-grown larva. The larva pupates within this.

g. Pupal covering with hole cut from within on one side to permit beetle to emerge.

h. Appearance of pupal covering after emergence of beetle.



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Photogravure, Survey of India Offices, Calcutta, January 1903.

CYRTOTRACHELUS LONGIPES.

PLATE X.

FIG. 1. **RHYNCHOLUS SP.** *a*. Dorsal and side view of beetle; *b*. Piece of Blue pine wood showing gallery made by the beetle.

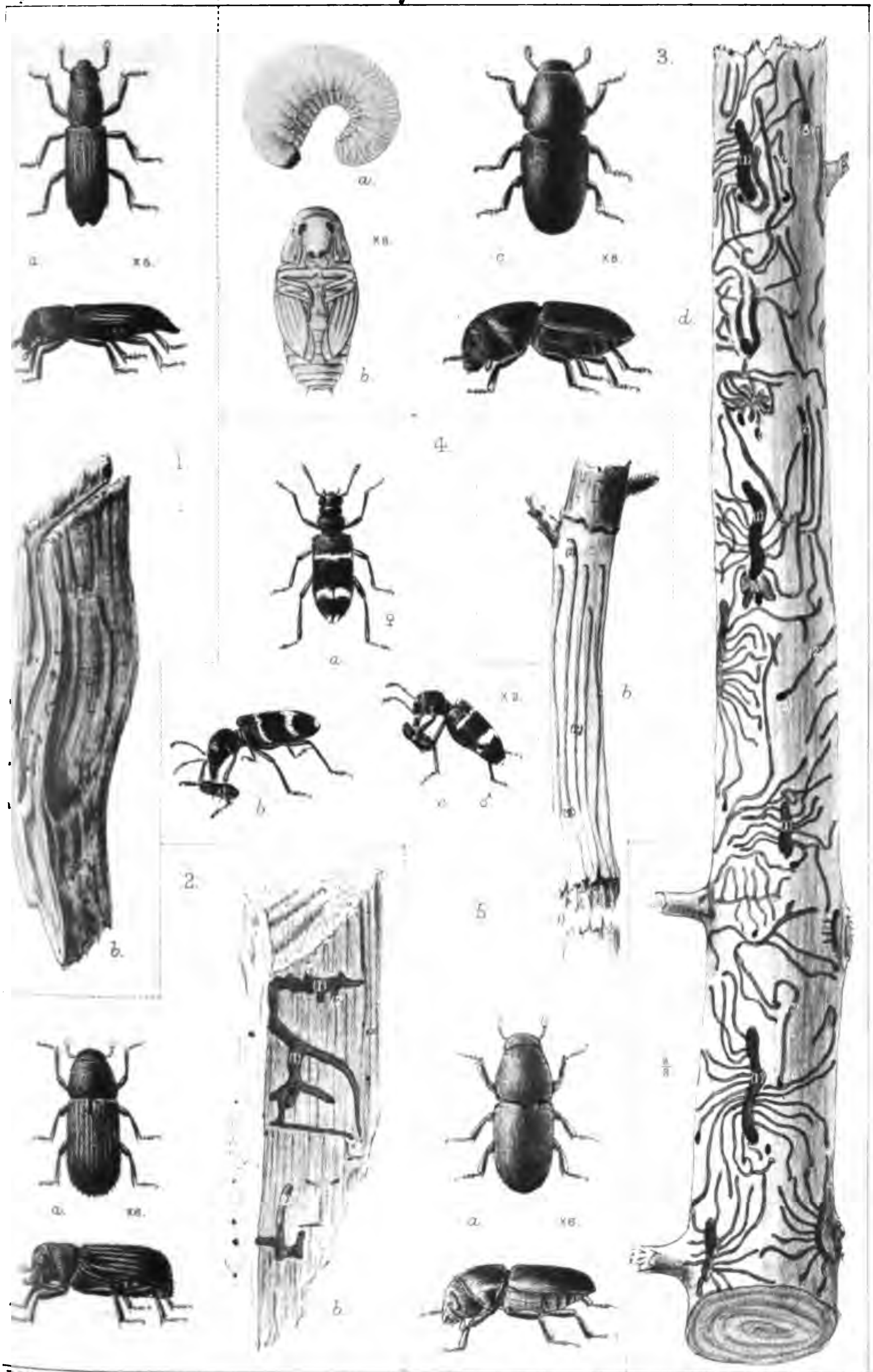
„ 2. **HYLASTES SP.** *a*. Dorsal and side view of beetle; *b*. Piece of Blue pine wood showing the egg-gallery made by the ♀ beetle.

„ 3. **SCOLYTUS MINOR**, MS. *a*. Larva, side view; *b*. pupa, ventral view; *c*. dorsal and side view of beetle; *d*. portion of a young deodar sapling showing egg-galleries of mother beetles, (1) larval galleries, (2), and pupating chambers, (3), made by the larvæ in the wood at the end of their tunnels—two-thirds natural size.

„ 4. **CLERUS SP.** *a*. Dorsal view of ♀ beetle; *b*. a beetle seizing a *Scolytus major* bark-borer; *c*. A ♂ beetle feeding upon a *Scolytus major* bark-borer. [*b* and *c*, after drawings from life by author.]

„ 5. **SCOLYTUS DEODARA**, MS. *a*. Dorsal and side view of beetle; *b*. Portion of a deodar branch with lower bark removed. The branch was girdled at (1) by this beetle, the eggs being laid in little indentations just above the girdle. The larvæ hatching from these eggs bored the galleries (2) up the stem.

[From a drawing by the Author.]



B Mondul, del.

Photogravure. Survey of India Offices, Calcutta, January 1903.

1. RHYNCHOLUS SP.
2. HYLASTES SP.
3. SCOLYTUS MINOR. MS.
4. CLERUS SP.
5. SCOLYTUS DEODARA. MS.

PLATE XI.

◆

Portion of a deodar log from a tree whose death was attributed to the attacks of the Scolytid bark-borers *Scolytus major*, MS. and *Scolytus minor*, MS. (slightly under ½ natural size)—

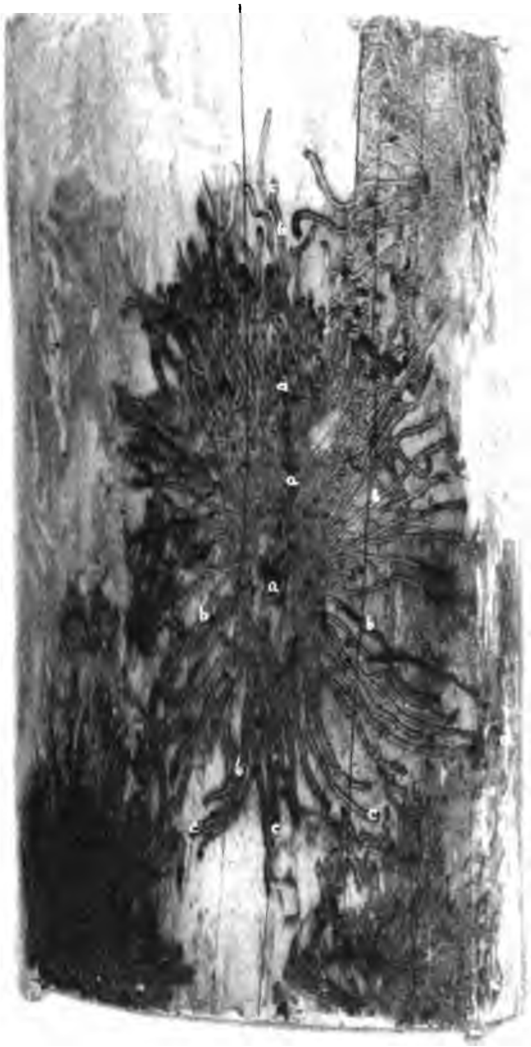
a, a, a. Egg-gallery made by mother beetle of *Scolytus major*.

b, b. Larval galleries made by the larvæ hatching out from the eggs laid in small notches at the sides of the egg-gallery.

c, c. Pupating chambers in wood at the end of larval galleries bored by larvæ before changing into the pupal state.

d. The smaller egg and larval galleries of *Scolytus minor*, MS.

[Photograph by Mr. J. H. Lace, Conservator of Forests, Bengal.]



Slightly under ½ nat. size.

J H. Lace. Photo.
Photogravure. Survey of India Offices, Calcutta, February 1903.

EGG AND LARVAL GALLERIES OF *SCOLYTUS MAJOR, MS.*
AND *SCOLYTUS MINOR, MS* IN DEODAR WOOD.

PLATE XII.

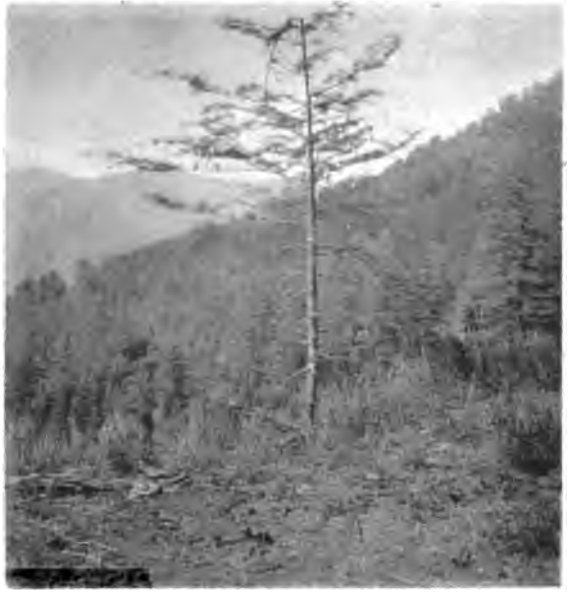
◆

FIG. 1. A young 8′ deodar sapling showing the leading shoot girdled 16″ from the top by the Deodar branch girdler, *Scolytus deodara* MS. The top is dead and fallen over to the left in the picture.

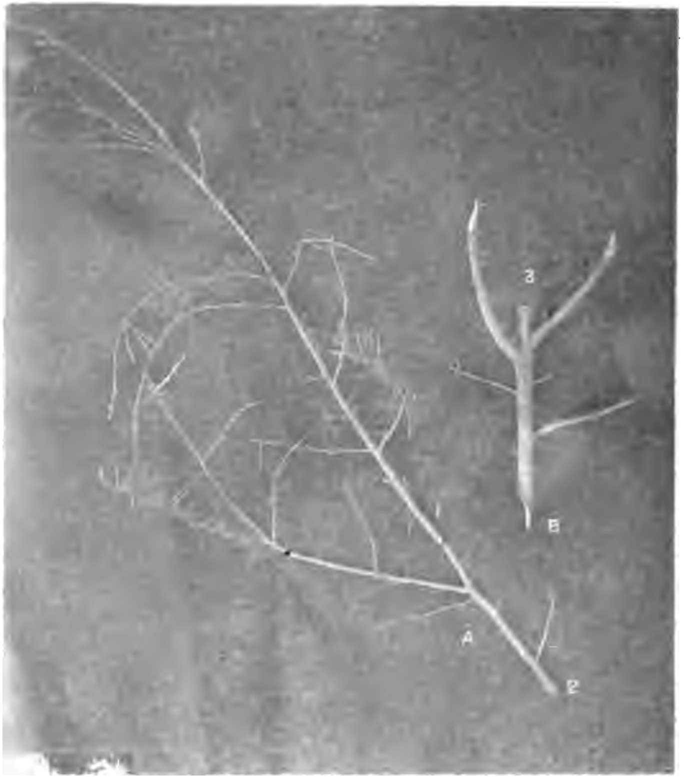
[Photograph by Mr. J. W. Oliver,
Director, Imperial Forest School.]

FIG. 2. A. A deodar branch girdled in two places at 1 and 2 by the Deodar branch girdler, *Scolytus deodara,* MS.; B. Top of a 10′ deodar sapling showing the leading shoot girdled at 3 some years previously by the Deodar branch girdler. Two side shoots were taking the place of the girdled leader.

[Photograph by Mr. A. Jackson,
Deputy Director, Imperial Forest School.]



J. W. Oliver, Photo.



H. Jackson, Photo.

Photogravure.

Survey of India Offices, Calcutta, January 1903.

Fig 1. A YOUNG 8 FOOT DEODAR SAPLING WITH TOP GIRDLED 16" DOWN BY SCOLYTUS DEODARA, MS., THE DEODAR BRANCH GIRDLER.

Fig 2. A DEODAR BRANCH GIRDLED IN TWO PLACES AT 1 AND 2 BY THE DEODAR BRANCH GIRDLER (*S. DEODARA*). B LEADING SHOOT OF A 10" DEODAR SAPLING GIRDLED AT 3 BY *S. DEODARA*. TWO SIDE SHOOTS ARE TAKING THE GIRDLED LEADERS PLACE.

PLATE XIII.

Fig. 1. Tomicus sp. *a.* Larva; *b.* Pupa; *c.* Dorsal and side view of beetle; *d.* Inner surface of a piece of Blue pine bark showing pairing chamber, *p*, and four uncompleted egg-galleries, *e*.

„ 2. Polygraphus major, MS. *a.* dorsal and side view of beetle; *b.* portion of a Blue pine branch showing the pairing chamber, (*p*), egg-galleries, (*e*), and pupating chambers of the larvæ, (*m*), of this beetle; *c.* inner surface of a piece of Blue pine bark showing the pairing chamber, (*p*), egg-galleries, (*e*), and larval galleries, (*l*), of this *Polygraphus*.

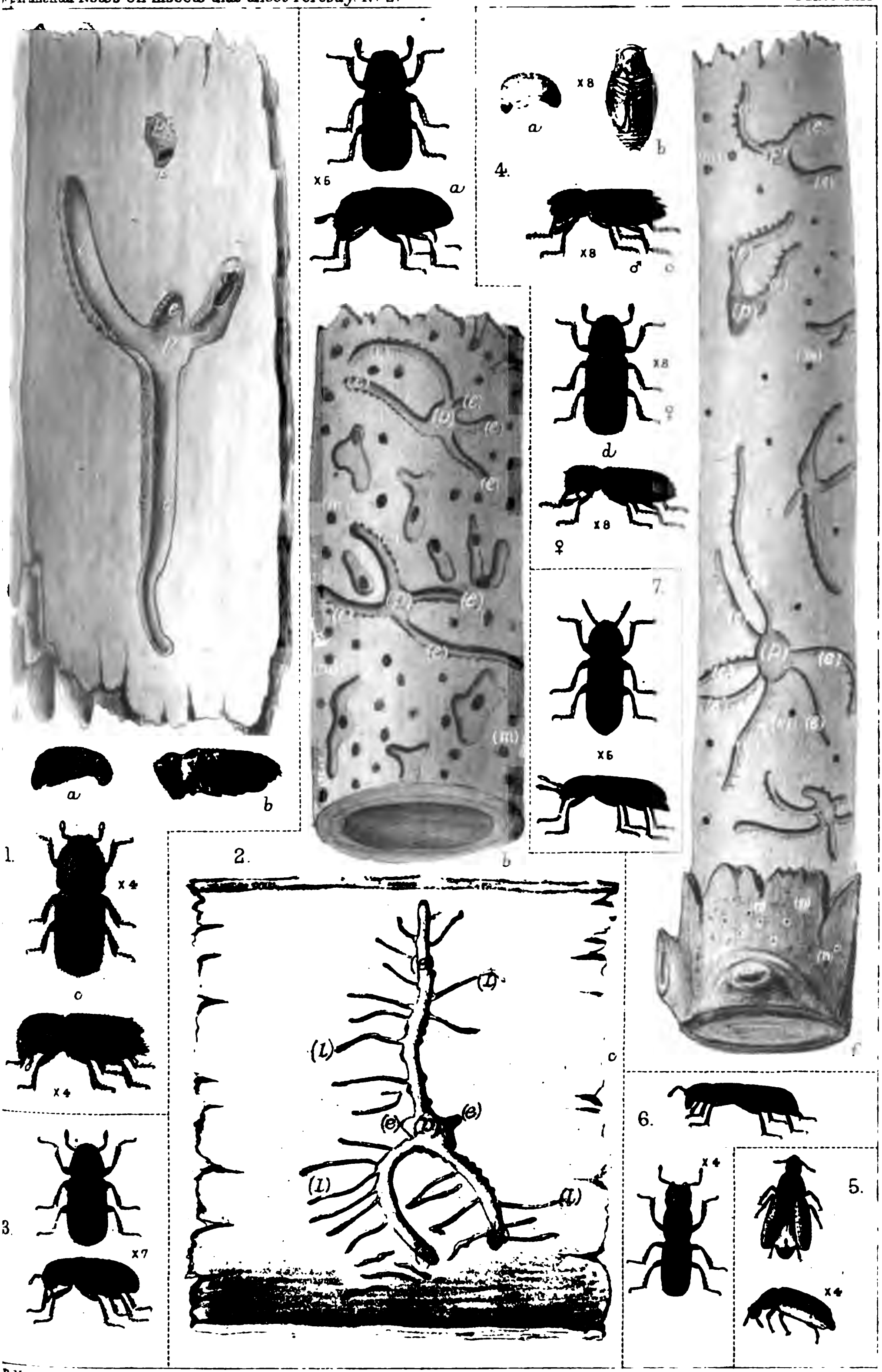
„ 3. Polygraphus minor, MS. Dorsal and side view of beetle.

„ 4. Pityogenes coniferæ, MS. *a.* larva; *b.* ventral view of pupa; *c.* side view of the ♂ beetle; *d.* dorsal and side view of ♀ beetle; *f.* portion of a Blue pine branch, showing pairing chamber, (*p*), egg-galleries, (*e*), pupating chambers of larva, (*m*), and entrance holes of beetle, (*n*), on the outer side of bark.

„ 5. Hypophlœus flavipennis, Mots. Dorsal and side view of beetle.

„ 6. Niponius canalicollis, Lew. Dorsal and side view of beetle.

„ 7. Cucujus (?) sp. Dorsal and side view of beetle.



B Mondul, del.

Photogravure, Survey of India Offices, Calcutta, February, 1903.

1. TOMICUS SP.
2. POLYGRAPHUS MAJOR, MS.
3. POLYGRAPHUS MINOR, MS.
4. PITYOGENES CONIFERAE, MS.
5. HYPOPHLOEUS FLAVIPENNIS, MOTS.
6. NIPONIUS CANALICOLLIS, LEW.
7. CUCUJUS ? SP.

PLATE XIV.

Portion of the inner bark of a Blue pine severely attacked by *Tomicus* sp. (the Blue pine Tomicus).

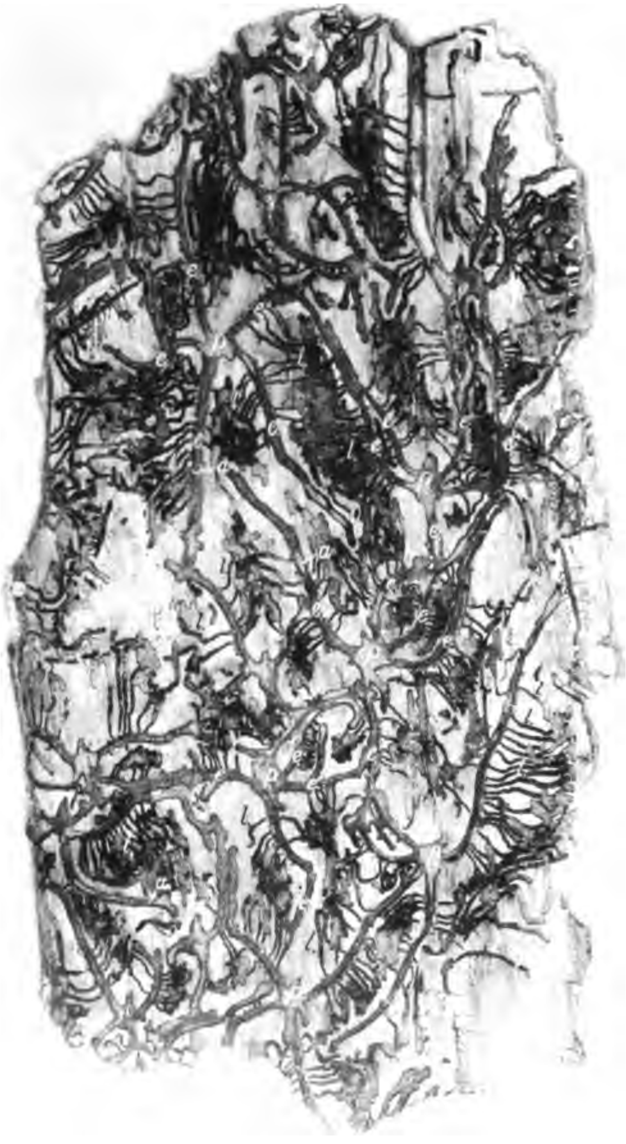
p, pairing chamber of ♂ and ♀ beetles;

e, egg-galleries made by female beetles;

a, air-hole made by female beetle to let air into the egg-gallery;

l, larval galleries.

[Photograph by Mr. J. H. Lace, Conservator of Forests, Bengal.]



⅖ nat size.

H. Lace. Photo.

Photogravure, Survey of India Offices, Calcutta, March 1903.

GALLERIES OF THE BLUE PINE TOMICUS, *TOMICUS SP.*,
IN THE BARK OF THE BLUE PINE, *PINUS EXCELSA*.

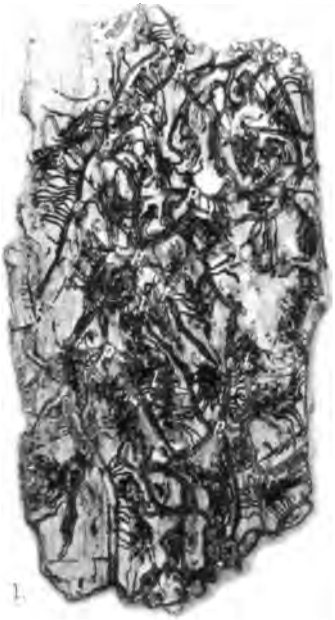
PLATE XV.

Fig. 1. Galleries of the Blue pine Tomicus, *Tomicus* sp., in Blue pine bark; *p*. pairing chamber; *e*. egg-gallery; *l*, larval gallery.

" 2. Galleries of *Polygraphus minor*, MS., on inner surface of Blue pine bark; *p*. pairing chamber; *e*, egg-gallery; *l*, larval galleries.

" 3. Galleries of *Tomicus* sp. and *Polygraphus minor* in Blue pine bark; *p*, pairing chamber; *e*. egg-gallery; *l*, larval gallery.

" 4. Galleries of *Tomicus* sp. and *Polygraphus minor* in Blue pine bark showing how they at times run into one another so as to be indecipherable.



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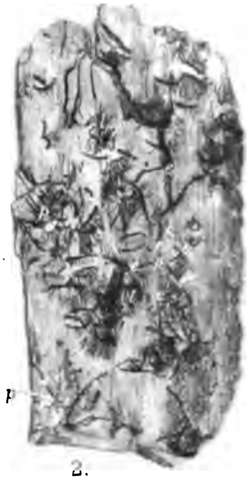

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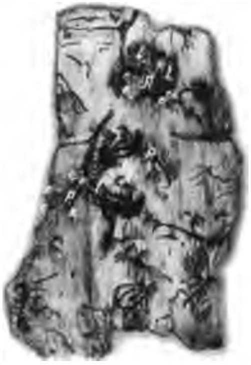

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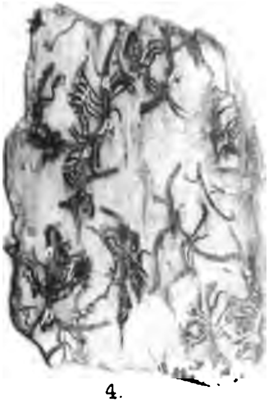


4.

J.H.Lace Photo.

Photogravure, Survey of India Offices, Calcutta, March 1903.

Fig 1. GALLERIES OF THE BLUE PINE TOMICUS, *TOMICUS* SP, IN BLUE PINE BARK.

Fig 2. GALLERIES OF *POLYGRAPHUS MINOR* MS. IN BLUE PINE BARK.

Fig 3. GALLERIES OF *TOMICUS* SP. AND *POLYGRAPHUS MINOR* IN BLUE PINE BARK.

Fig 4. ONE EGG GALLERY OF *TOMICUS* SP. & GALLERIES OF *P. MINOR* IN BLUE PINE BARK.

PLATE XVI.

FIG. 1. POLYGRAPHUS MINIMUS, MS. Dorsal and side view of the beetle.

„ 2. POLYGRAPHUS LONGIFOLIA, MS. *a*. Dorsal and side view of the beetle; *b*. Portion of a *Pinus longifolia* branch showing pairing chamber, (*p*), egg-gallery, (*e*), and larval gallery, (*l*), of this beetle.

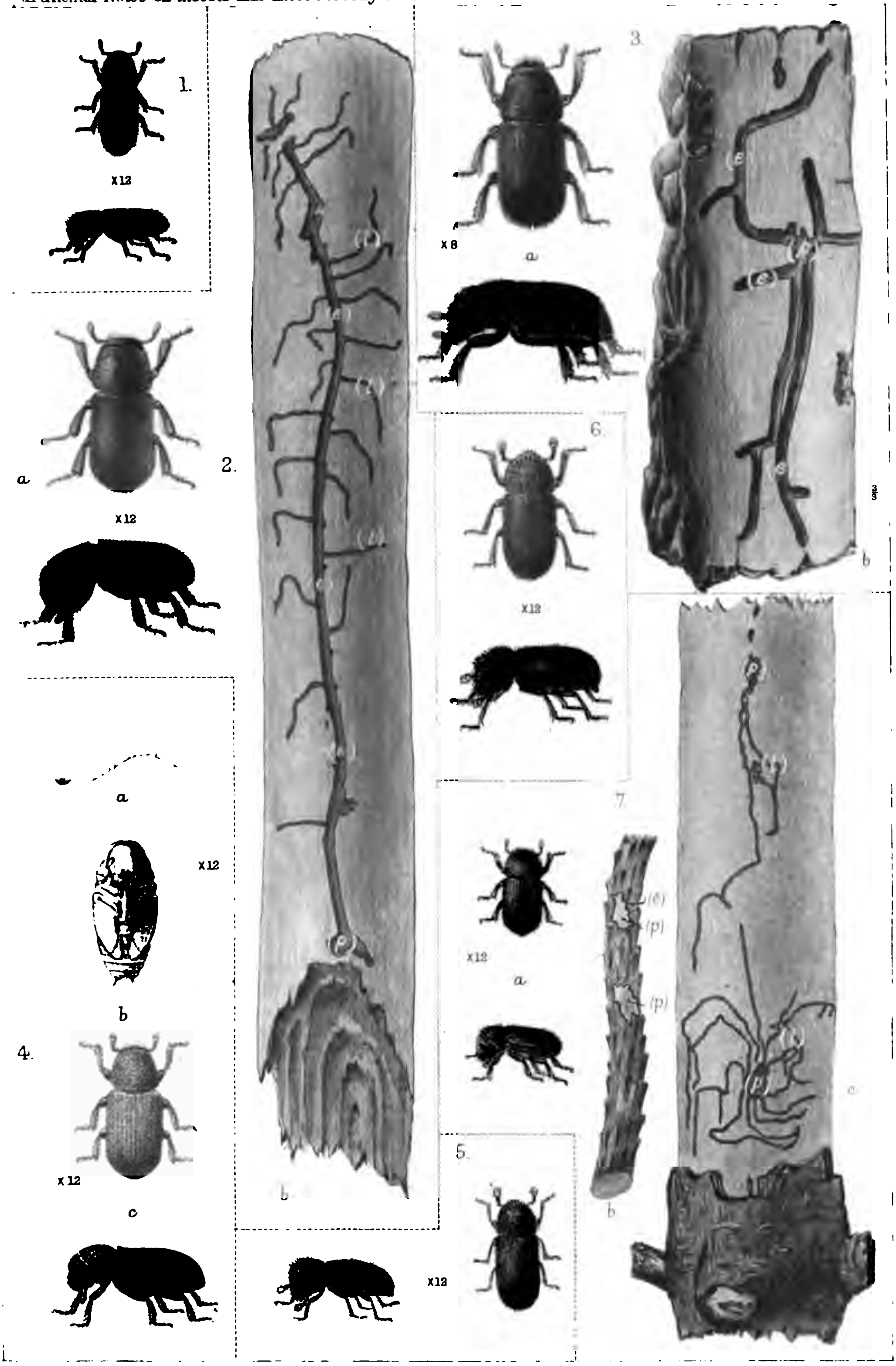
„ 3. HYLESINUS? sp. *a*. Dorsal and side view of beetle; *b*. Inner surface of a piece of Blue pine bark showing pairing chamber, (*p*), and egg-galleries, (*e*).

„ 4. CRYPHALUS BOSWELLIÆ, MS. *a*. Larva; *b*. Pupa, ventral view; *c*. dorsal and side view of the beetle.

„ 5. CRYPHALUS TECTONÆ, MS. Dorsal and side view of the beetle.

„ 6. CRYPHALUS MORINDA, MS. Dorsal and side view of the beetle.

„ 7. CRYPHALUS LONGIFOLIA, MS. *a*. Dorsal and side view of the beetle; *b*. Portion of a branchlet showing, (*p*), pairing chamber with, (*e*), the indentations made to enlarge it to deposit the eggs; *c*. Portion of a branch showing, (*p*), the pairing and egg chamber; *l*, the larval galleries.



S. B. Mondul. del.

Photogravure, Survey of India Offices, Calcutta, February, 1903

1. POLYGRAPHUS MINIMUS, MS.
2. POLYGRAPHUS LONGIFOLIA, MS.
3. HYLESINUS ? SP.
4. CRYPHALUS BOSWELLIAE, MS.
5. CRYPHALUS TECTONAE, MS.
6. CRYPHALUS MORINDA, MS.
7. CRYPHALUS LONGIFOLIA, MS.

PLATE XVII.

◆

FIG. 1. **CRYPHALUS? MAJOR**, MS. *a.* Dorsal and side view of male beetle; *b.* Dorsal and side view of the female beetle; *c.* Attacked *Pinus longifolia* branchlets, showing, (*p*), the pairing chamber, (*f*), the horizontal tunnel down to the pith, and (*e*), the egg gallery; *d.* Larger branchlet showing the same as *c.*; *g.* Piece of a larger *P. longifolia* branch severely attacked by this beetle, showing how the galleries run into one another and become indecipherable on such occasions.

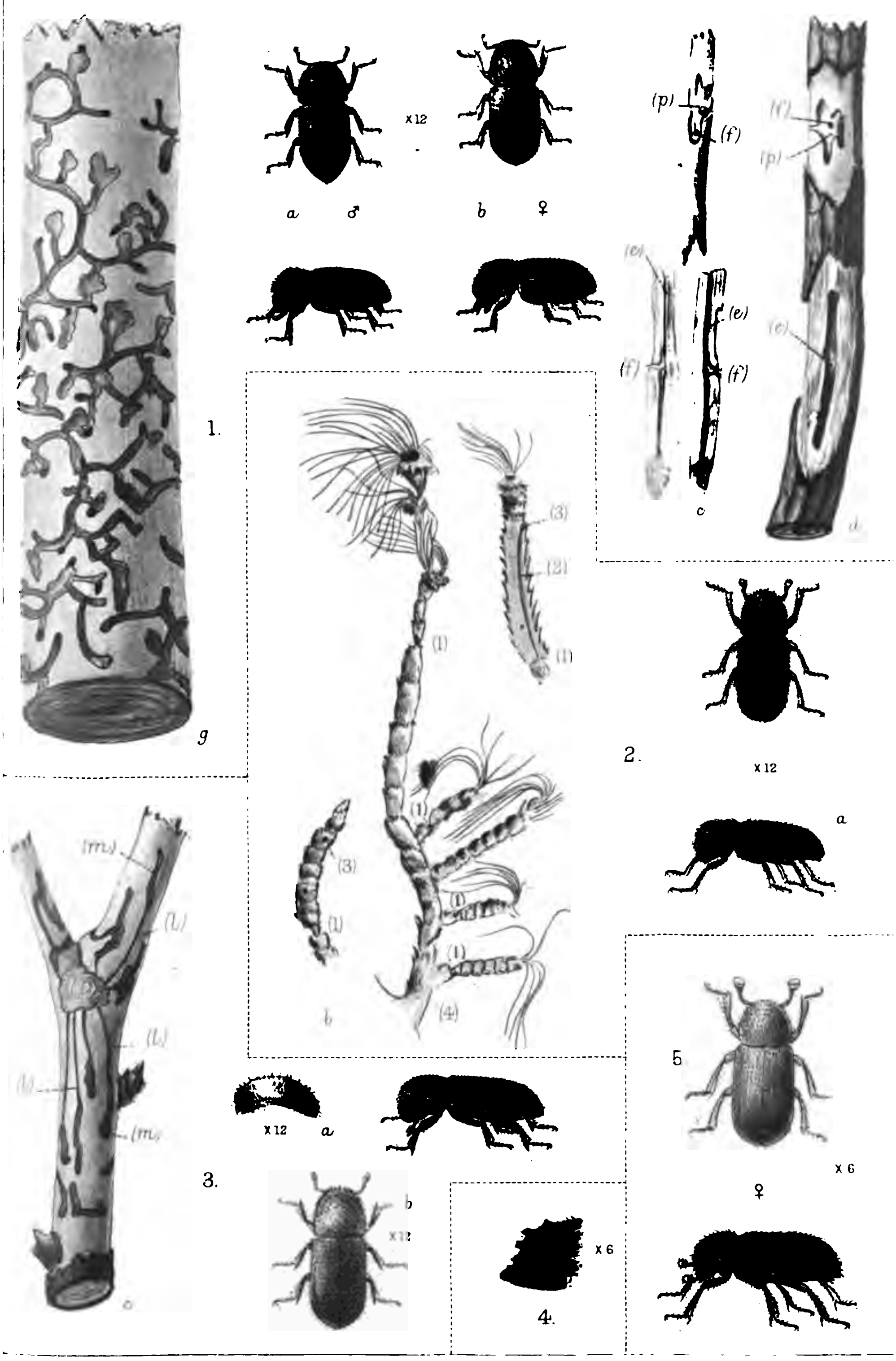
„ 2. **CRYPHALUS? DEODARA**, MS. *a.* Dorsal and side view of beetle; *b.* Deodar branchlets showing method of attack of this insect: (1) the girdle, (2) section of branch showing the larval tunnel, (3) horizontal gallery and exit hole made by beetle on maturing, (4) branchlet girdled in several places at (1) by this beetle.

[From a drawing by the author.]

„ 3. **HYPOBORUS?** sp. *a.* Larva; *b.* Dorsal and side view of the beetle; *c.* Branch with bark removed showing, (*p*), the pairing chamber, (*l*), larval galleries, and, (*m*), the pupating chambers of larvæ.

„ 4. **TOMICUS LONGIFOLIA**, MS. Side view of hinder part of abdomen showing the size and number of teeth at the side of the apical excavation.

„ 5. **ECCOPTOPTERA SEXDENTATA**, Mots. Dorsal and side view of the beetle.



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Photogravure, Survey of India Offices, Calcutta, February, 190

1. CRYPHALUS ? MAJOR, MS.
2. CRYPHALUS ? DEODARA, MS.
3. HYPOBORUS ? SP.
4. TOMICUS LONGIFOLIA, MS.
5. ECCOPTOPTERA SEXDENTATA, MOTS.

PLATE XVIII.

Fig. 1. Teak leaf showing the characteristic method of defoliation of the larva of *Hyblæa puera*, Cram.

„ 2. Portion of a Teak leaf showing the skeletonizing method of defoliation of the larva of *Pyrausta machæralis*, Wlk.—

[Drawn from a photograph by Mr. R. S. Hole, Deputy Conservator of Forests.]

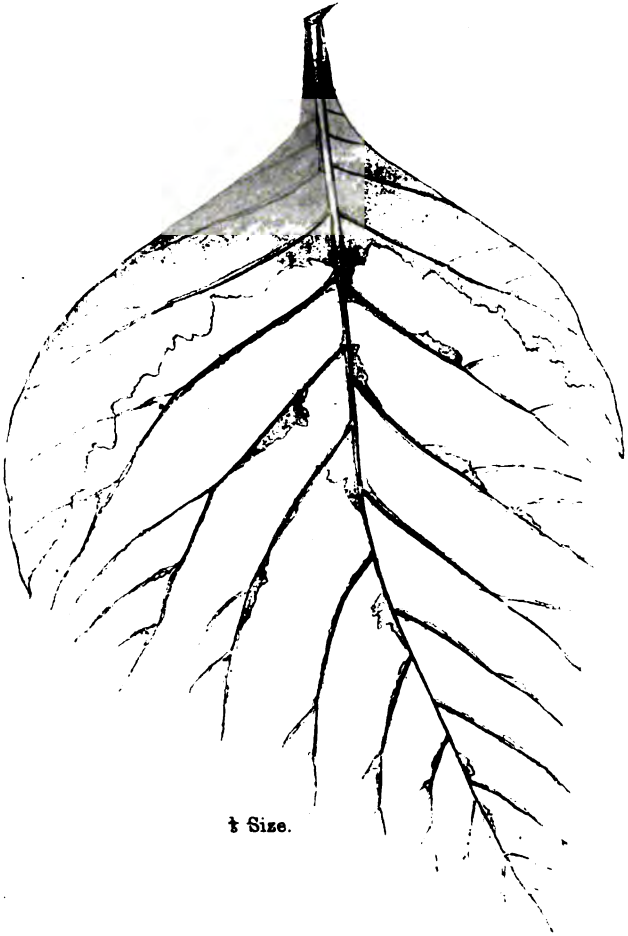

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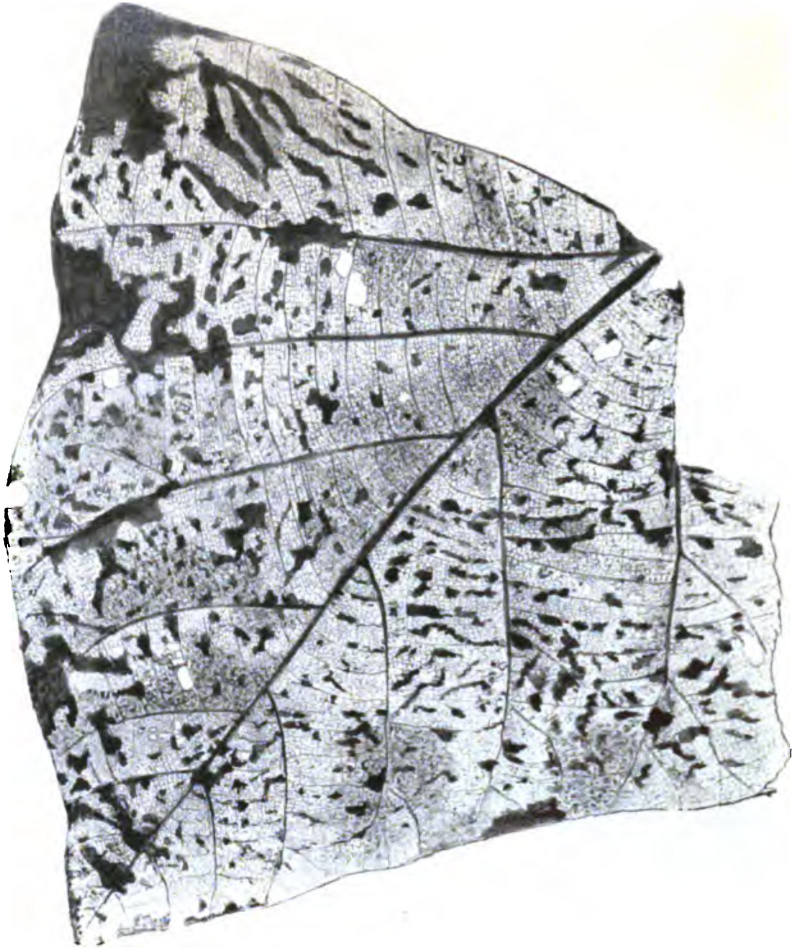
Fig. 1. TEAK LEAF SHOWING CHARACTERISTIC METHOD OF DEFOLIATION BY THE LARVAE OF *HYBLAEA PUERA* CRAM.



R. S. Hole. Photo.

Photogravure. Survey of India Offices, Calcutta, March 1903.

Fig. 2. PORTION OF A TEAK LEAF SHOWING THE SKELETONIZING METHOD OF DEFOLIATION OF THE LARVAE OF *PYRAUSTA MACHŒRALIS,* WLK.

PLATE XIX.

FIG. 1. HYBLÆA PUERA, var. NIGRA, MS. *a.* Dorsal and side view of the larva; *b.* Pupa in silken cocoon attached to a portion of a teak leaf; *c.* male moth; *d.* female moth.

" 2. PYRAUSTA MACHŒRALIS, Wlk. Dorsal view of the larva.

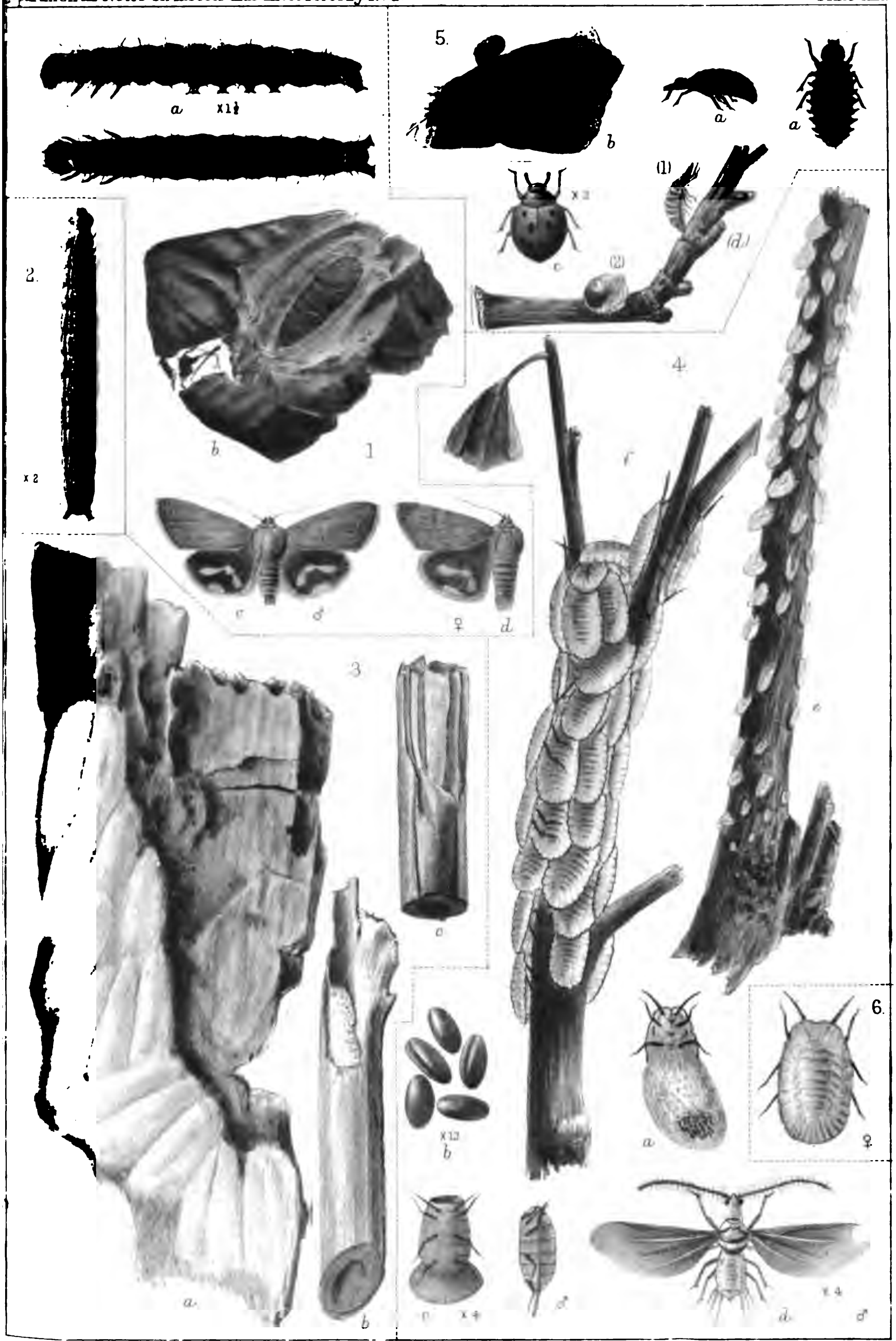
" 3. HYPSIPYLA ROBUSTA, Moore. *a.* Under surface of a piece of tún bark showing a matted felt-like mass of cocoons of this insect; *b.* A tún branch hollowed out by the larva showing the mass of excreta and wood-dust which fills the boring; *c.* A cocoon *in situ* in a hollowed-out twig.

" 4. MONOPHLEBUS STEBBINGI, Green. *a.* Female insect showing cottony sac in which the eggs are laid; *b.* egg; *c.* Ventral and side view of the male pupa (?) case; *d.* Mature male insect; *e.* A sâl branch showing the cast larval skins attached to it by the sugary secretion; *f.* A sâl branch showing the way the ♀ scales cluster together round it whilst feeding.

[From a drawing by the author.]

" 5. COCCINELLA sp. *a.* Dorsal and side view of the larva; *b.* pupa sessile upon a sâl leaf; *c.* mature lady-bird beetle; *d.* sâl twig with, (1) pupating larva, (2) sessile pupa, upon it.

" 6. MONOPHLEBUS STEBBINGI, var. MANGIFERÆ, Green. Dorsal view of mature female scale.



S. B. Mondul, del.

Photogravure, Survey of India Offices, Calcutta, March 1903.

1 HYBLAEA PUERA, VAR. NIGRA, MS.
2. PYRAUSTA MACHOERALIS, WLK.
3 HYPSIPYLA ROBUSTA, MOORE.
4. MONOPHLEBUS STEBBINGI, GREEN.
5. COCCINELLA SP.
6. MONOPHLEBUS STEBBINGI, VAR. MANGIFERAE, GREEN.